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CONFERENCE 14 - 17 DECEMBER 2021
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TOKYO INTERNATIONAL FORUM, JAPAN

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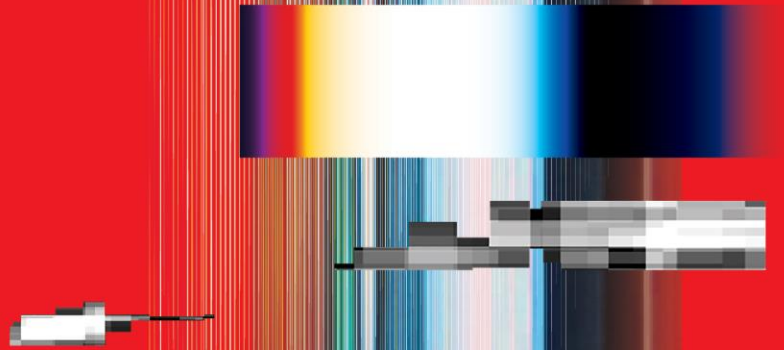
Rapid Prototyping for XR

Mark Billinghurst, Univ. South Australia

Michael Nebeling, University of Michigan



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Course Instructors

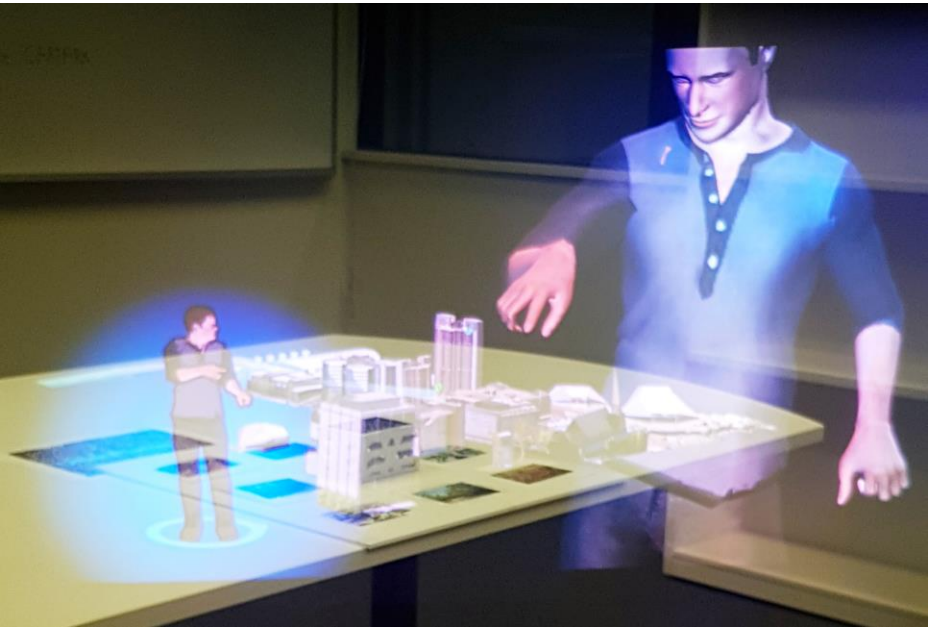
Mark Billinghurst

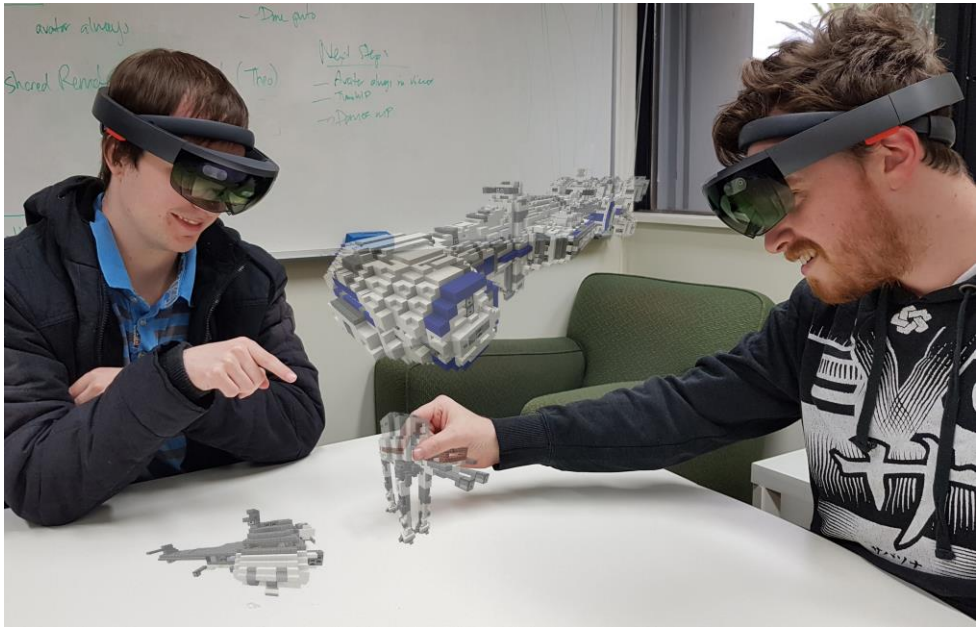
- Professor at the University of South Australia, and University of Auckland
- Director of the Empathic Computing Laboratory
- Research expertise in AR, VR, collaborative systems, Empathic Computing

Michael Nebeling

- Assistant Professor at the University of Michigan
- Director of the Information Interaction Lab
- Created the XR MOOC
- Research interests in AR/ VR toolkits, interaction techniques, collaboration, equity, ethics & privacy

How do you Prototype Interfaces Like This?





What you will learn..

What this course will cover in depth…

- Overview of the XR design process
- Classification of XR prototyping methods
- Low-fidelity prototyping
- High-fidelity prototyping (with interactions)
- Classification of XR authoring tools
- Overview XR development tools
- XR design guidelines
- Research directions in XR prototyping

What we will <u>not</u> cover in depth…

- Advanced XR concepts & technologies
- Building your own XR devices or add-ons
- Immersive audio
- Haptics
- Programming with XR tools like Unity

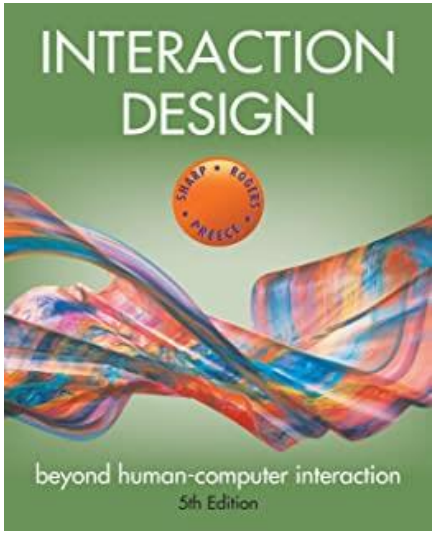
The Prototyping Process

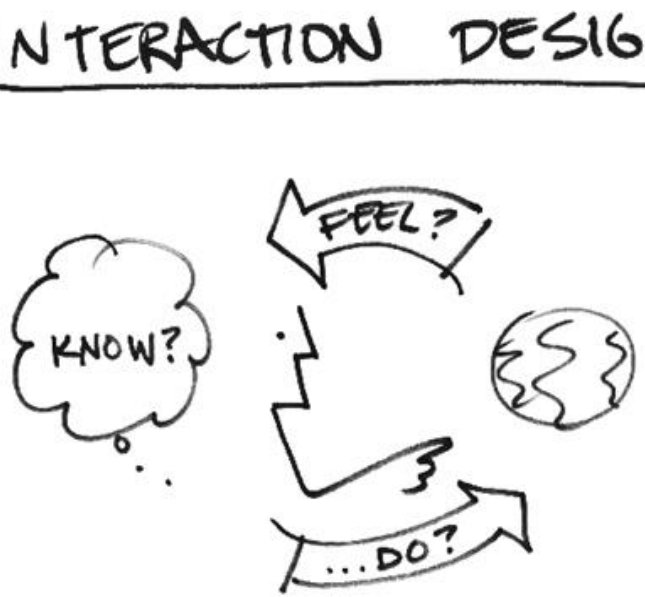
Interaction Design

“Designing interactive products to support people in their everyday and working lives”

Preece, J., (2002). Interaction Design

Design of User Experience with Technology

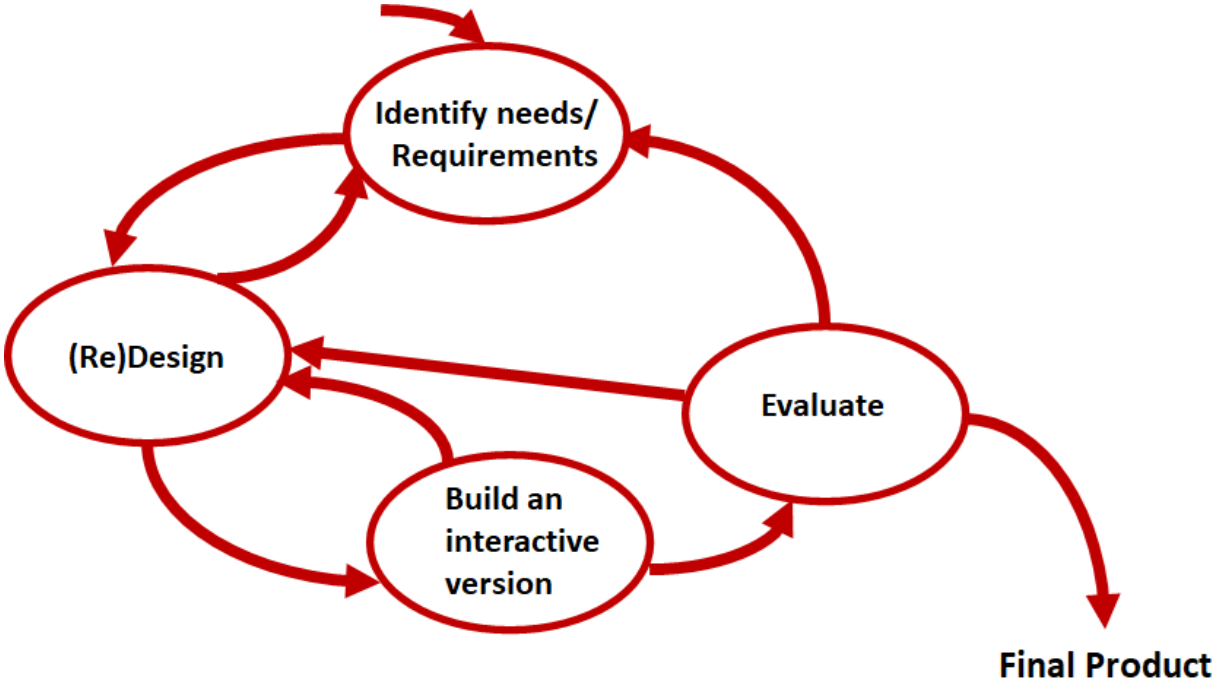




Bill Verplank

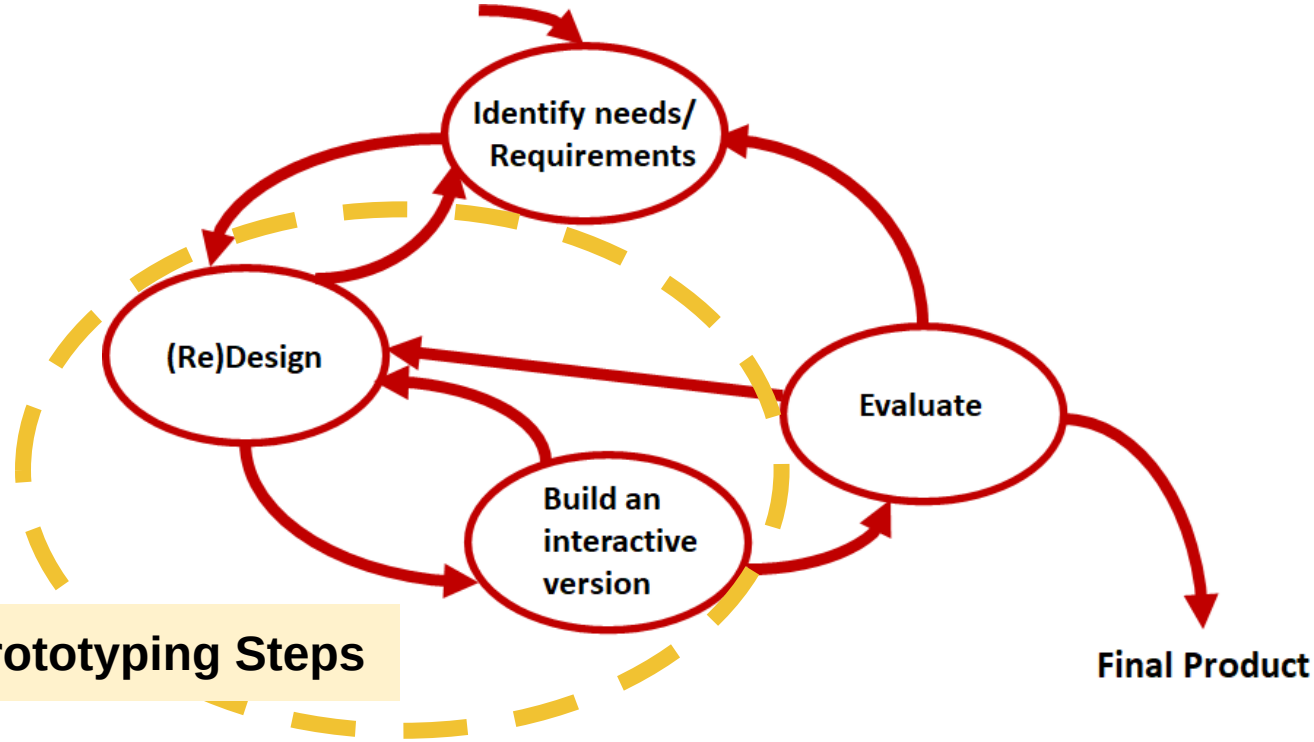
- Interaction Design involves answering three questions:
  - *What do you do?* - How do you affect the world?
  - *What do you feel?* – What do you sense of the world?
  - *What do you know?* – What do you learn?

Typical Interaction Design Cycle



Develop alternative prototypes/concepts and compare them, And iterate, iterate, iterate....

Prototyping in Interaction Design



Key Prototyping Steps

How can we quickly prototype XR experiences with little or no coding?

Why Prototype?

- Quick visual design
- Capture key interactions
- Focus on user experience
- Communicate design ideas
- Learn by doing/experiencing

Typical Development Steps

- Sketching
- Storyboards
- UI Mockups
- Interaction Flows
- Video Prototypes
- Interactive Prototypes
- Final Native Application

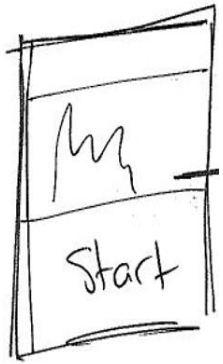
Increased Fidelity and Interactivity

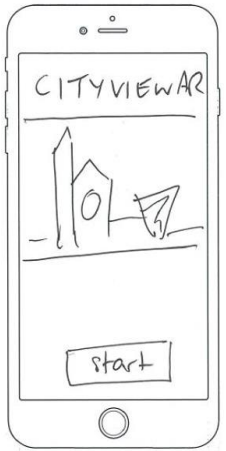
From Idea to Product

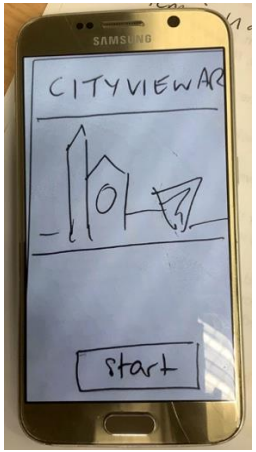
CityViewAR
University of Canterbury Education
3+
This app is available for your device
Add to Wishlist

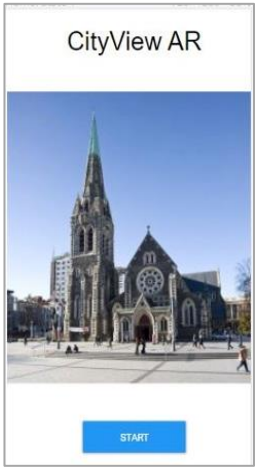
CityViewAR

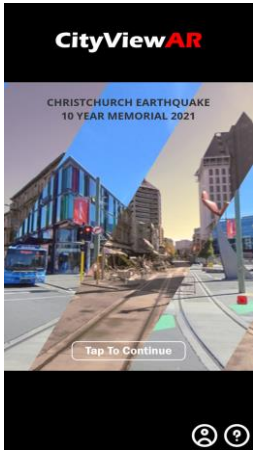
1. - - - - - - -
2. - - - - - - -
3. - - - - - - -
4. - - - - - - -
5. - - - - - - -
6. - - - - - - -









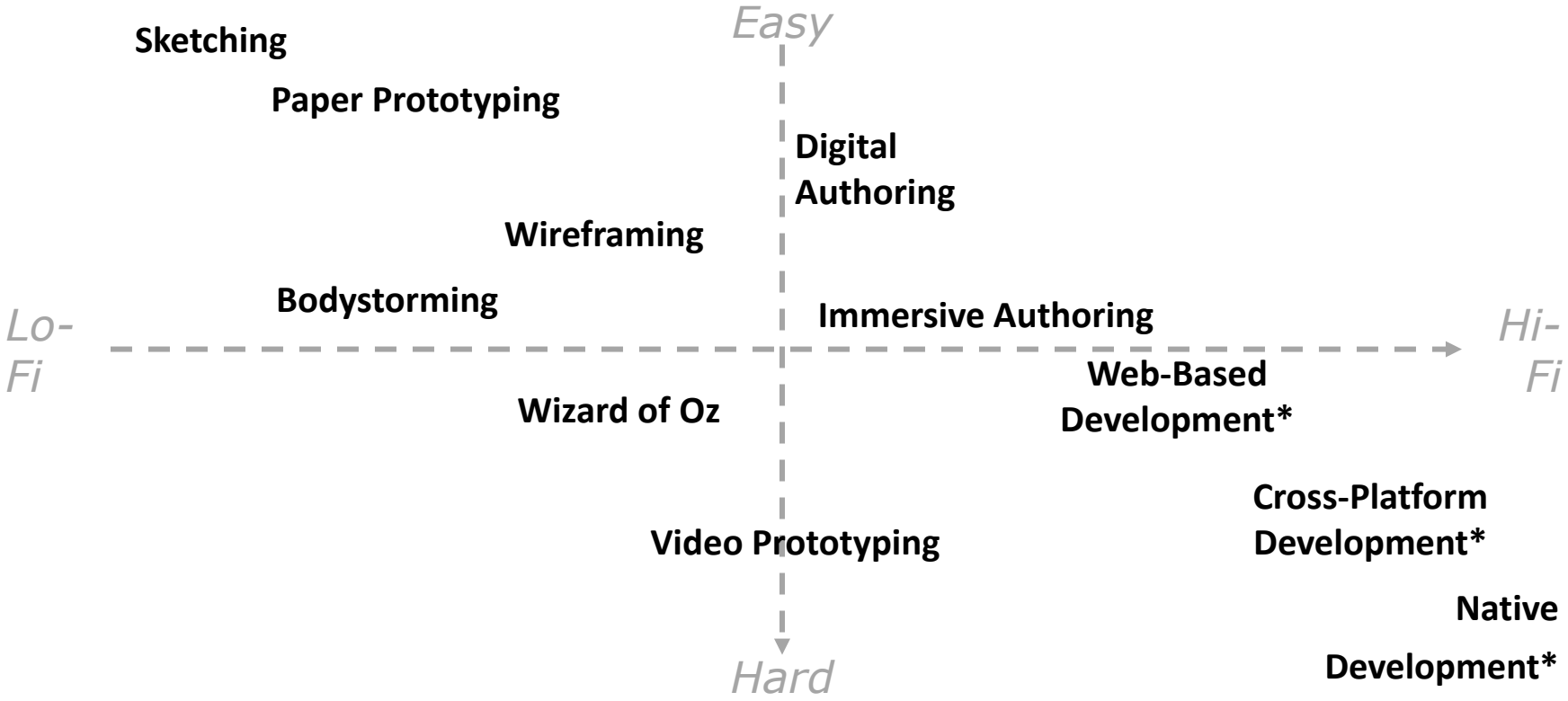


Develop

1. Define Requirements
2. Sketch Interface
3. Rough Wireframes
4. Interactive Prototype
5. High Fidelity Prototype
6. Developer Coding
7. User Testing
8. Deploy App

Iterate

XR Prototyping Techniques



** requires scripting and 3D programming skills*

XR Prototyping Tools

Low Fidelity (Concept, visual design)

- Sketching
- Storyboarding & wireframes
- Mockups
- Paper & video prototyping

High Fidelity (Interaction, experience design)

- Interactive sketching
- Desktop & on-device authoring
- Immersive authoring & visual scripting
- XR development toolkits

Advantages/Disadvantages

Prototype	Advantages	Disadvantages
Low-fidelity prototype	- low developmental cost - evaluate multiple design concepts	- limited error checking - navigational and flow limitations
High-fidelity prototype	- fully interactive - look and feel of final product - clearly defined navigational scheme	- more expensive to develop - time consuming to build - developers are reluctant to change something they have crafted for hours

Low Fidelity Tools

XR Prototyping Tools

Low Fidelity (Concept, visual design)

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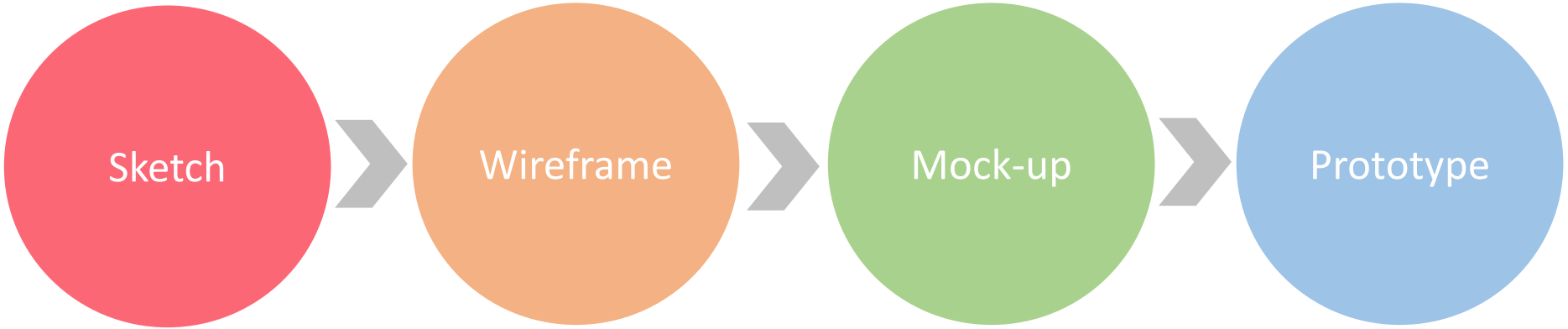
From Sketch to Prototype



Your Most Valuable Prototyping Tool..

Sketching

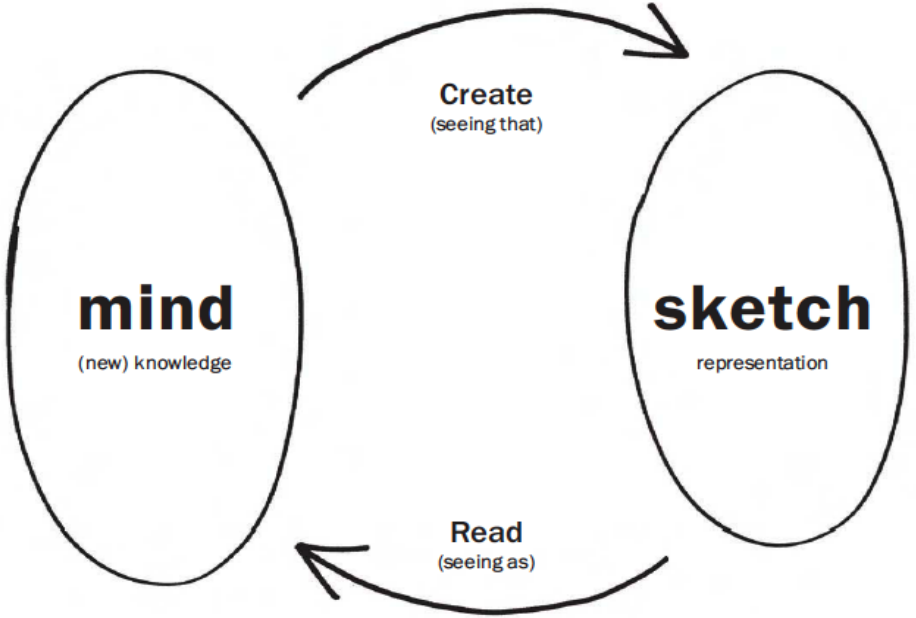
Not about drawing, but design

Sketching is a tool to help you:

- express
- develop, and
- communicate design ideas

Sketching is part of a process

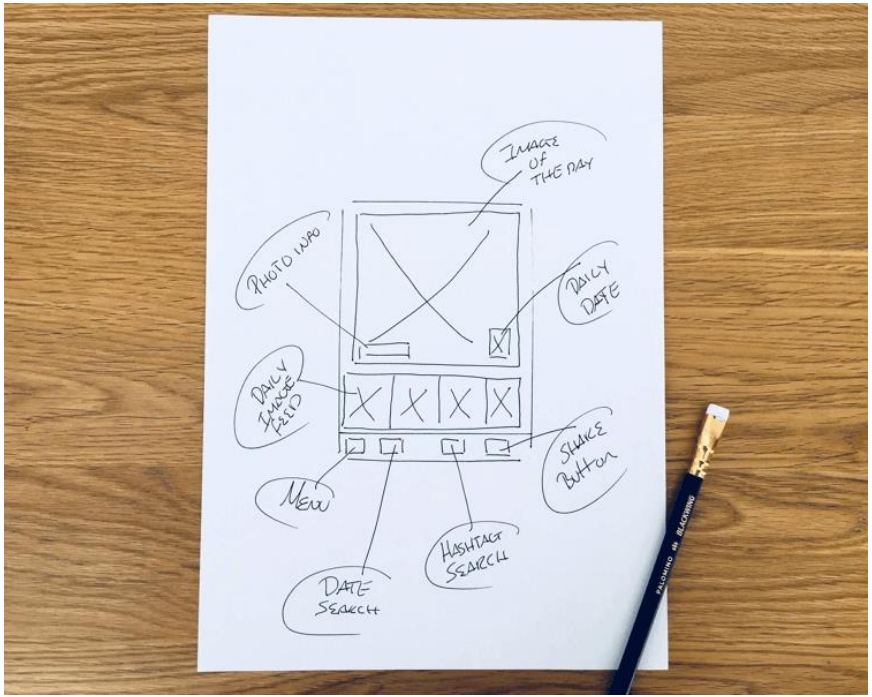
- Idea generation
- Design elaboration
- Design choices
- Engineering



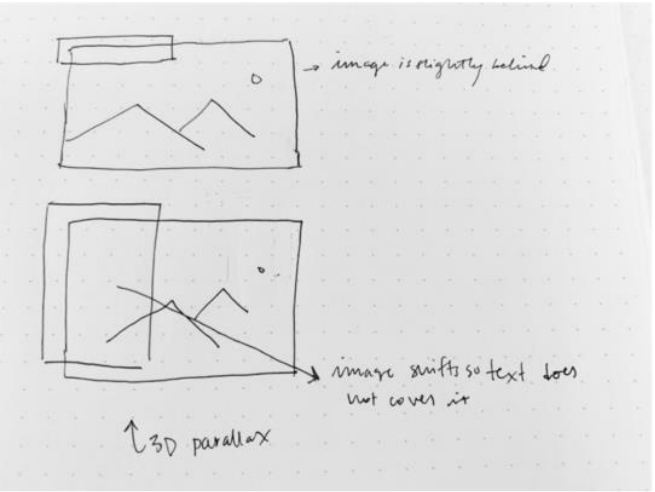
"Sketching is about the Activity not the Result" - Bill Buxton

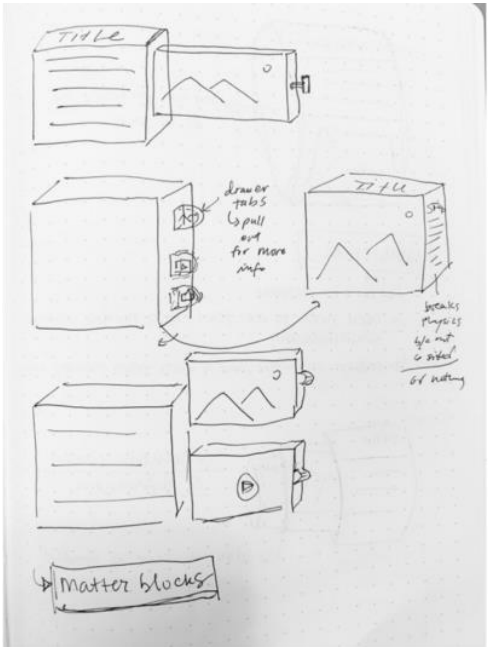
Buxton's Key Attributes of Sketching

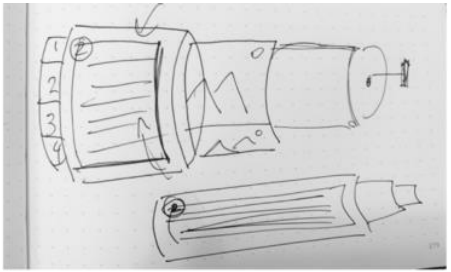
- Quick
  - Work at speed of thought
- Timely
  - Always available
- Disposable
  - Inexpensive, little investment
- Plentiful
  - Easy to iterate
- A catalyst
  - Evokes conversations

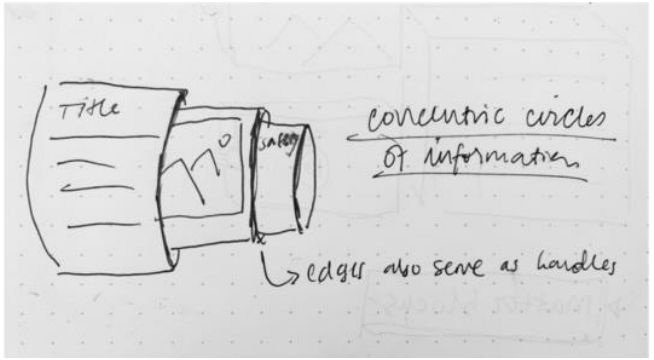


AR/VR Interface Design Sketches





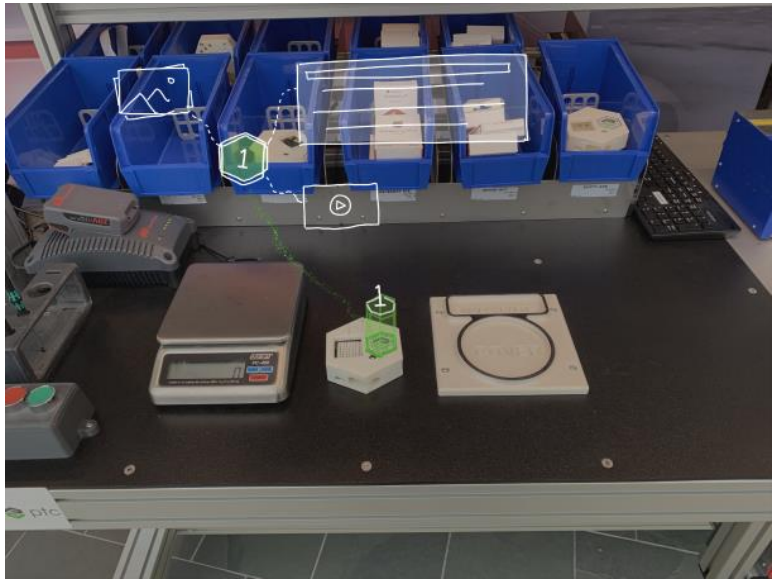




- Sketch out Design concept(s)

Luisa Vasquez - https://blog.prototypr.io/10-tips-for-rapid-prototyping-on-the-hololens-2-bda021e21743

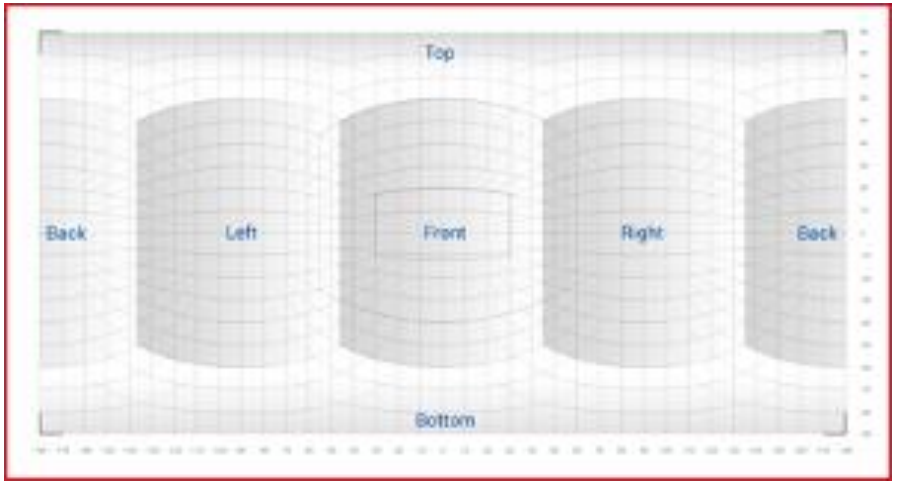
AR Augmented Sketch

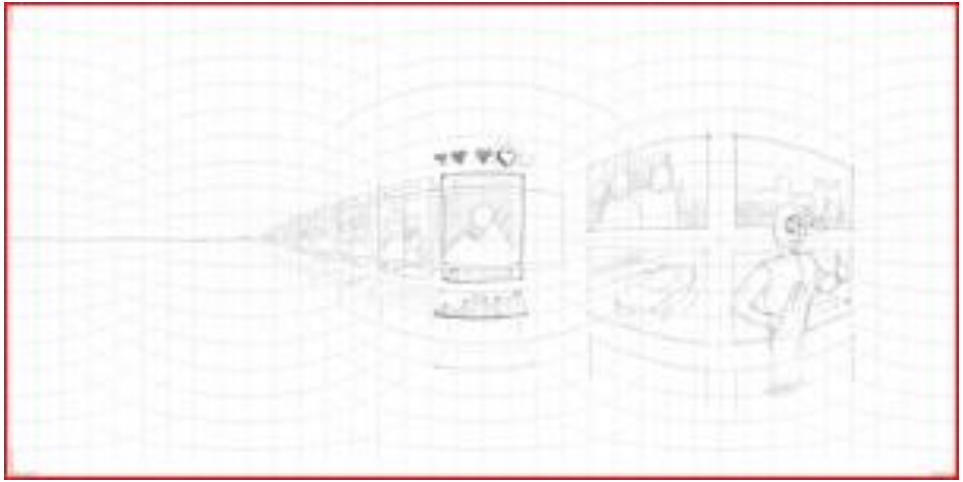


- Sketch on top of photos of real world – target workplaces

Luisa Vasquez - https://blog.prototypr.io/10-tips-for-rapid-prototyping-on-the-hololens-2-bda021e21743

Sketching VR Interfaces

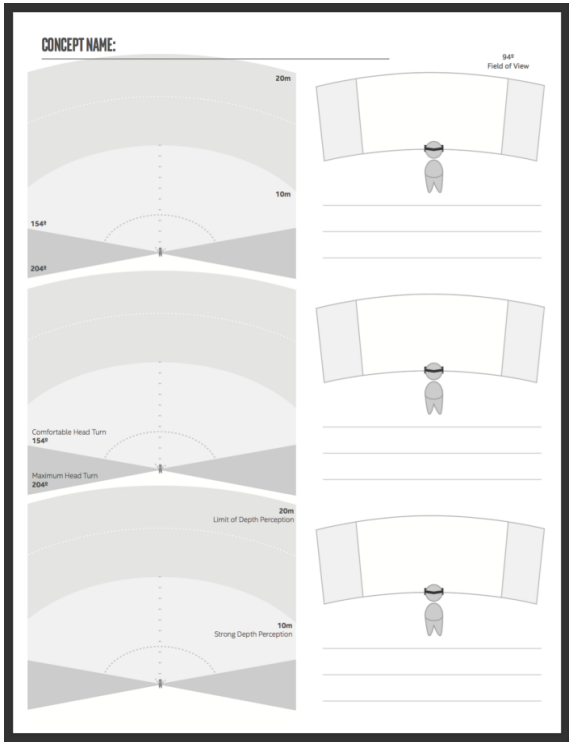


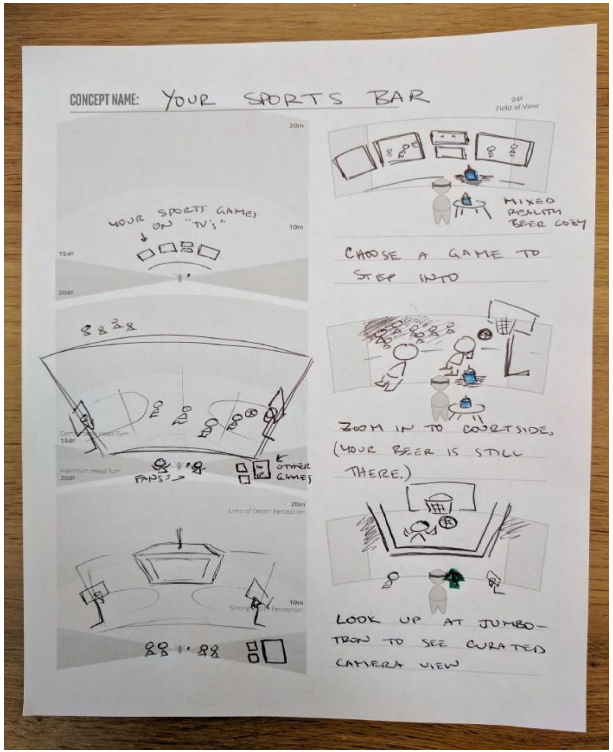


- Download 360 panorama template grid
- Draw interface ideas into grid
- Scan into 360 photo viewer for VR HMD

See https://virtualrealitypop.com/vr-sketches-56599f99b357

VR Sketch Sheets



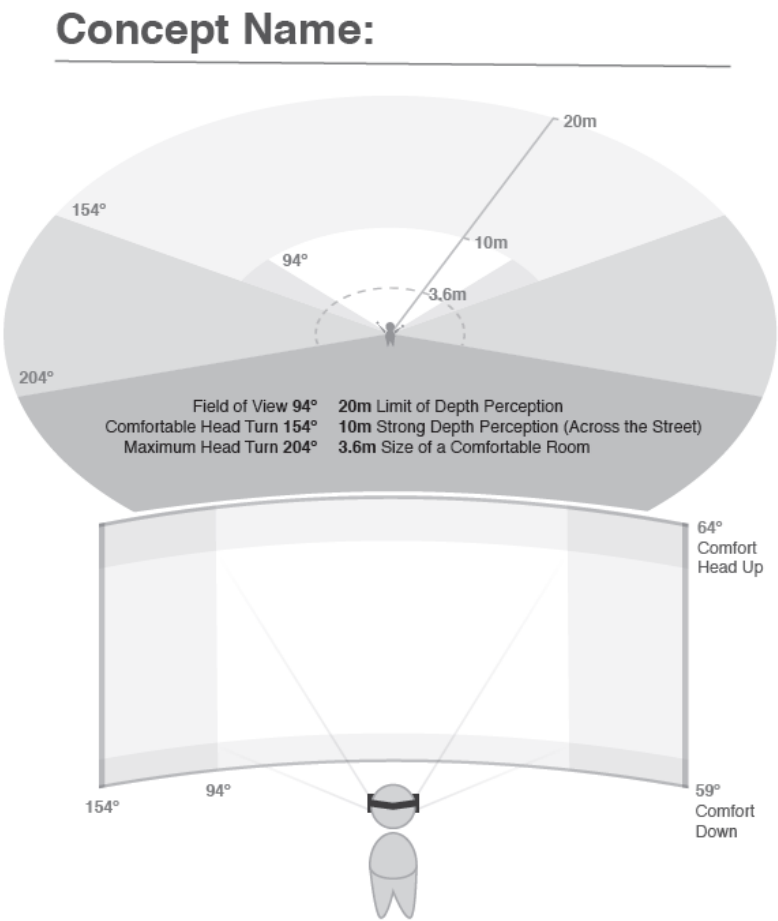


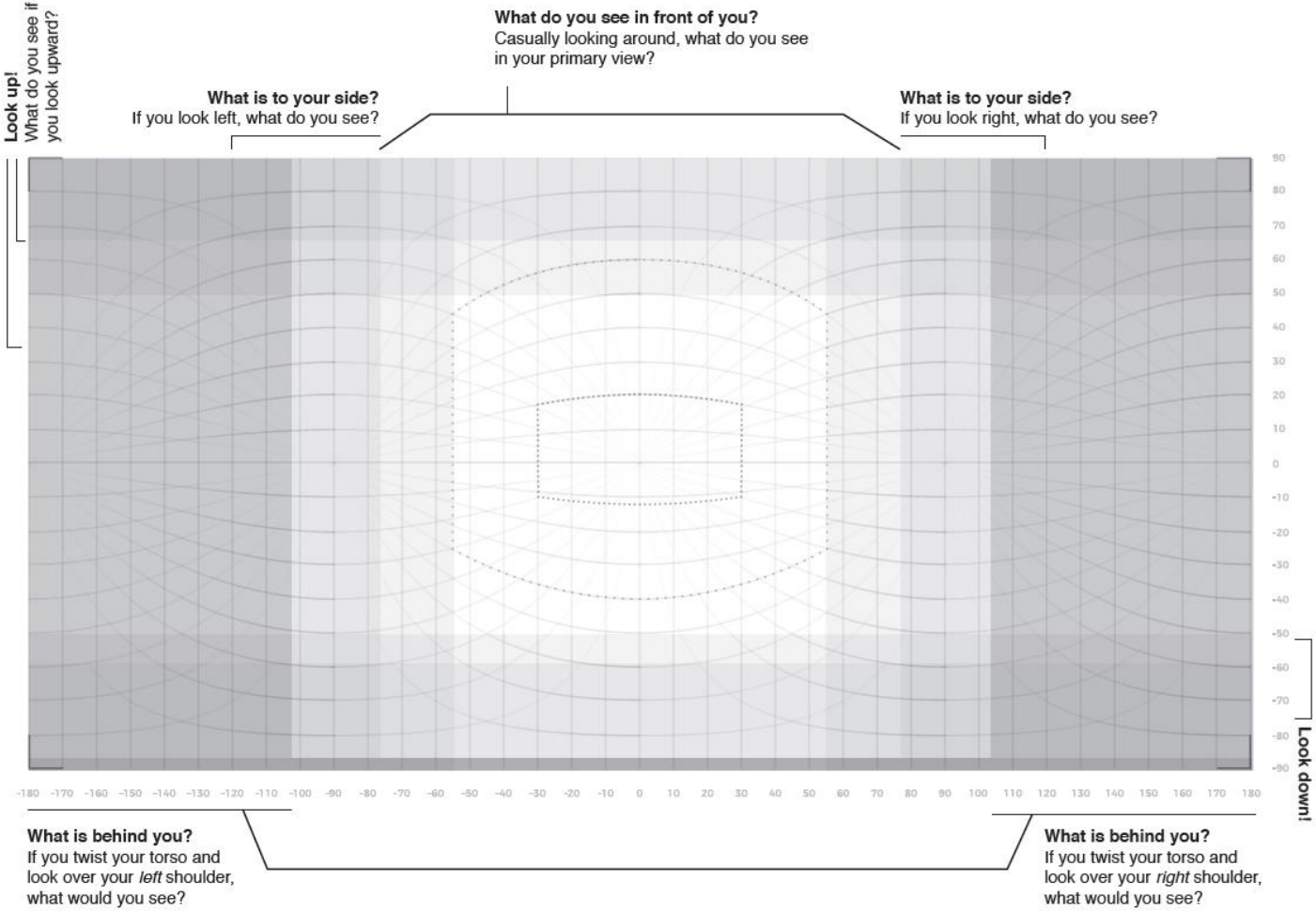
Available from https://blog.prototypr.io/vr-paper-prototyping-9e1cab6a75f3

Concept Sheet

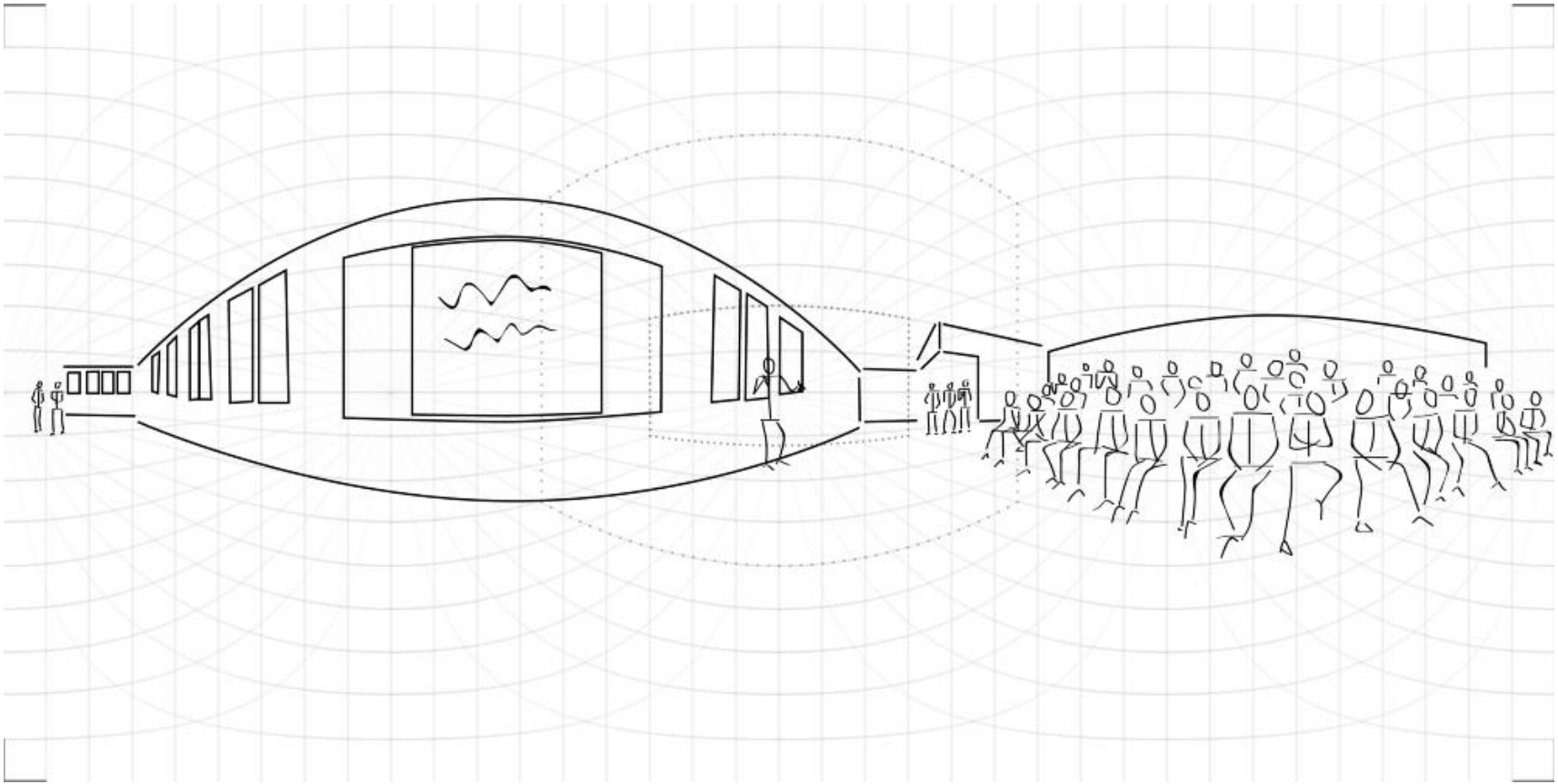
Top down and First Person view

Suitable for rough sketch

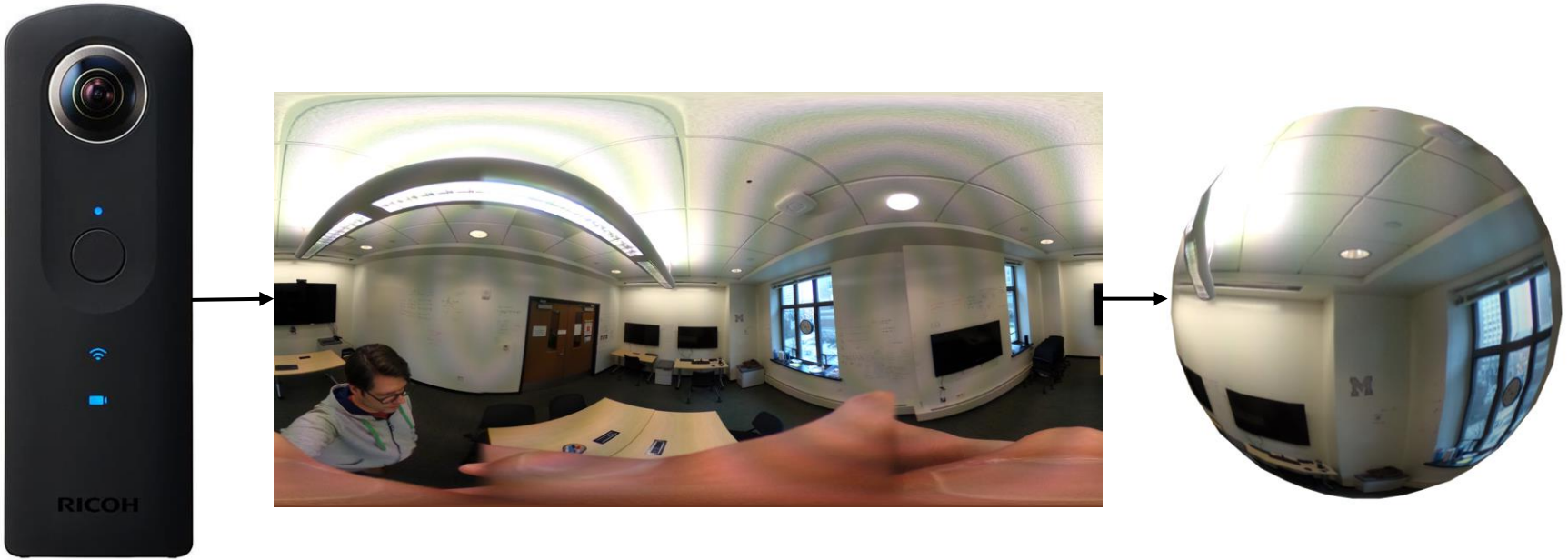



Look up!
What do you see if you look upward?
What do you see in front of you?
Casually looking around, what do you see in your primary view?
What is to your side?
If you look left, what do you see?
What is to your side?
If you look right, what do you see?
90 80 70 60 50 40 30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90
-180 -170 -160 -150 -140 -130 -120 -110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
Look down!
What is behind you?
If you twist your torso and look over your *left* shoulder, what would you see?
What is behind you?
If you twist your torso and look over your *right* shoulder, what would you see?

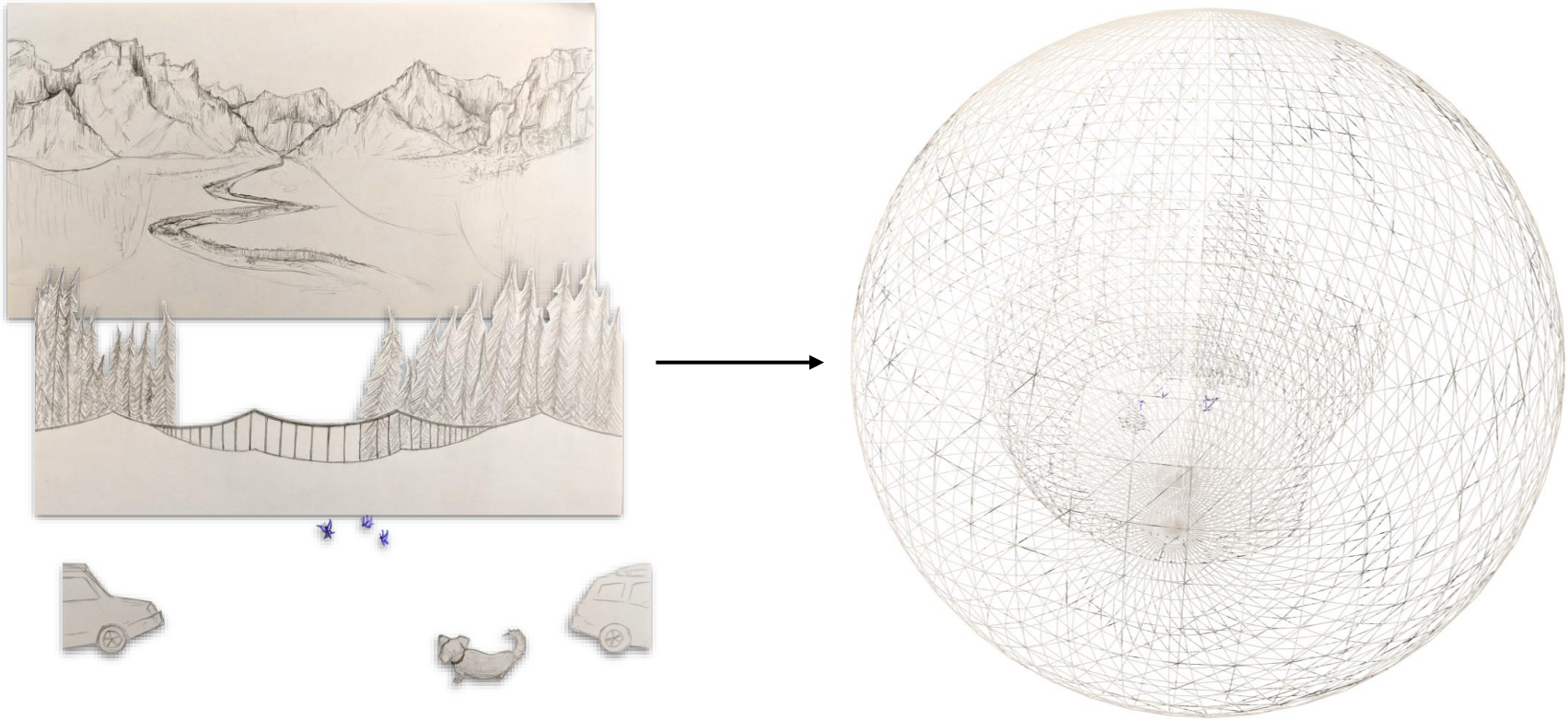
Sketching on the Template



360 Photo

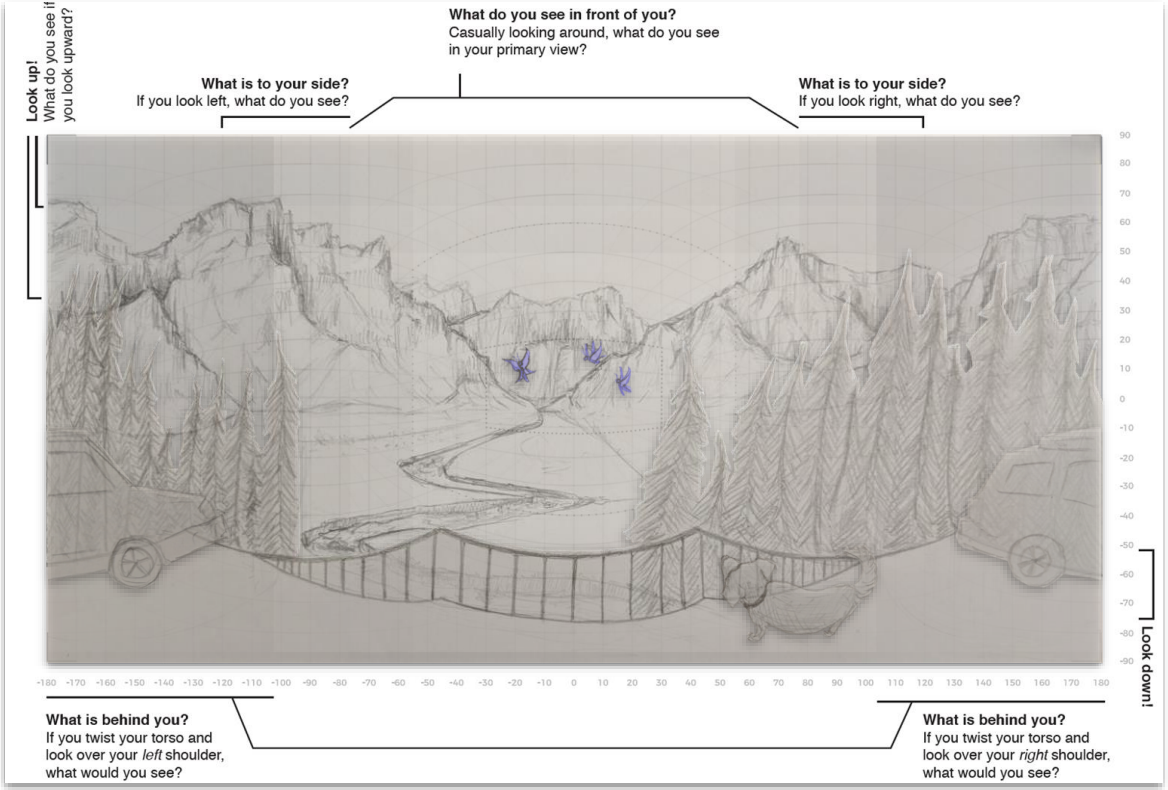


Layering 360 Sketches



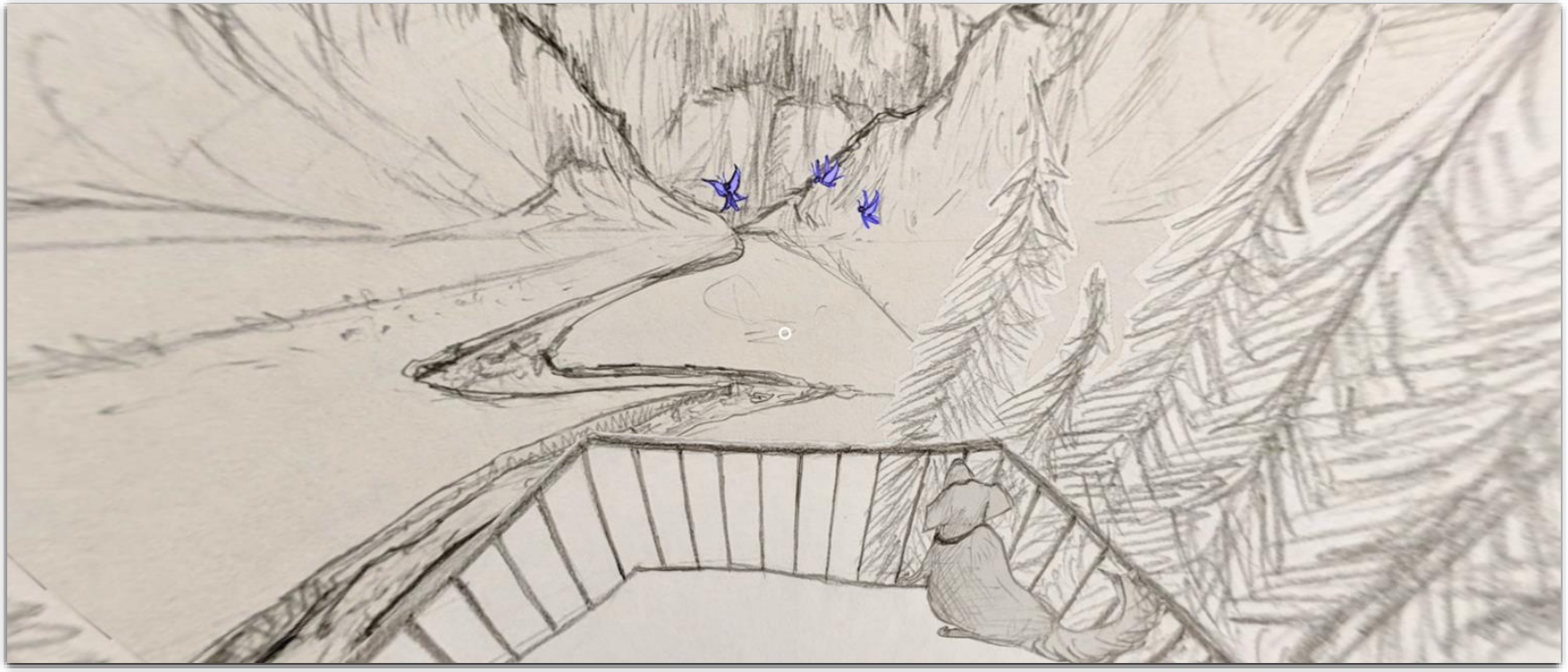
Nebeling & Madier: *360proto: Making Interactive Virtual Reality & Augmented Reality Prototypes from Paper* (CHI 2019)

360 Sketch



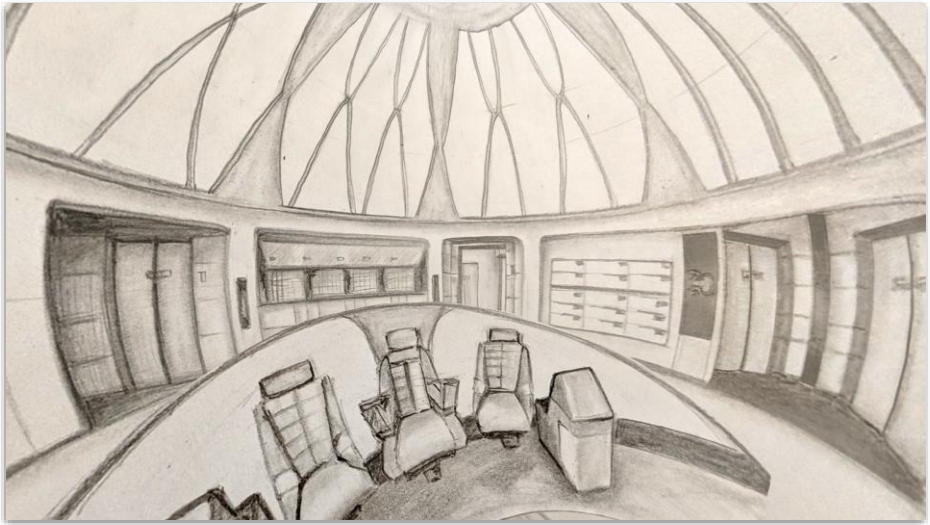
Nebeling & Madier: *360proto: Making Interactive Virtual Reality & Augmented Reality Prototypes from Paper* (CHI 2019)

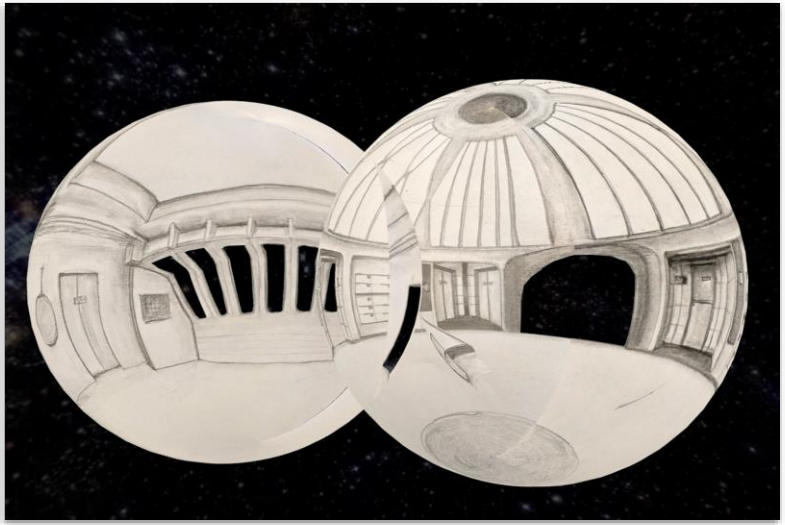
Layering 360 Sketches



Nebeling & Madier: *360proto: Making Interactive Virtual Reality & Augmented Reality Prototypes from Paper* (CHI 2019)

Intersecting 360 Sketches





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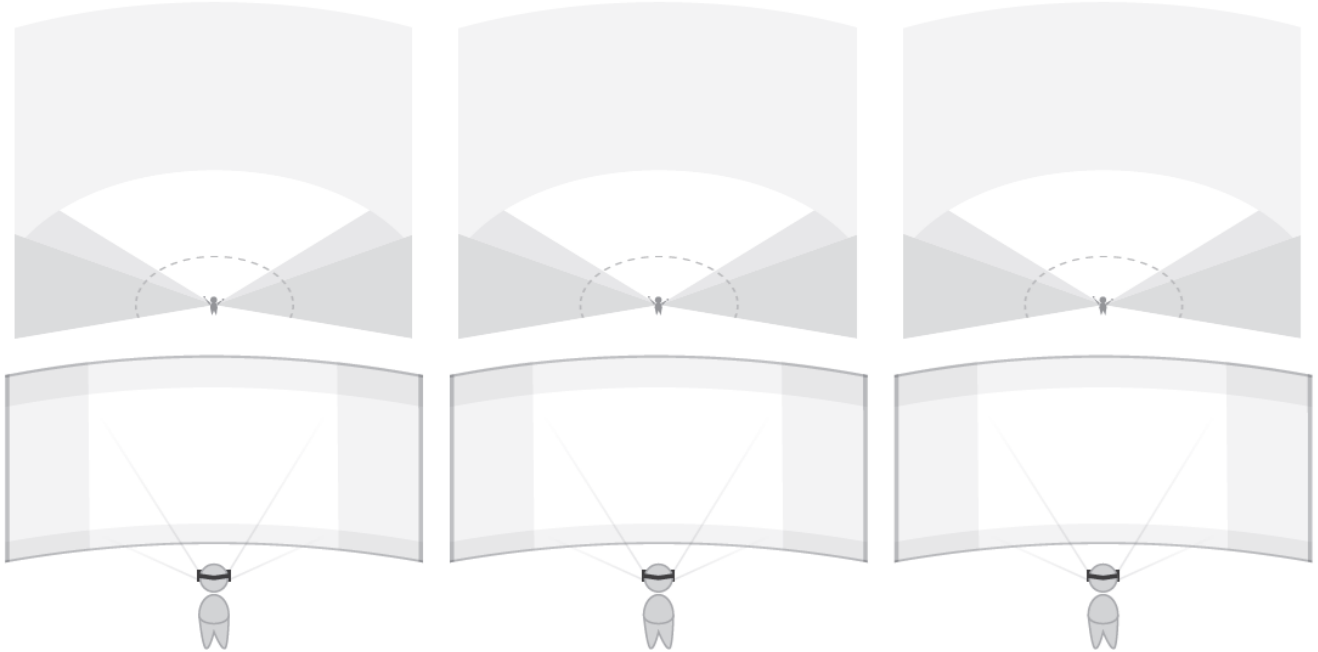
Storyboarding - Describing the Experience

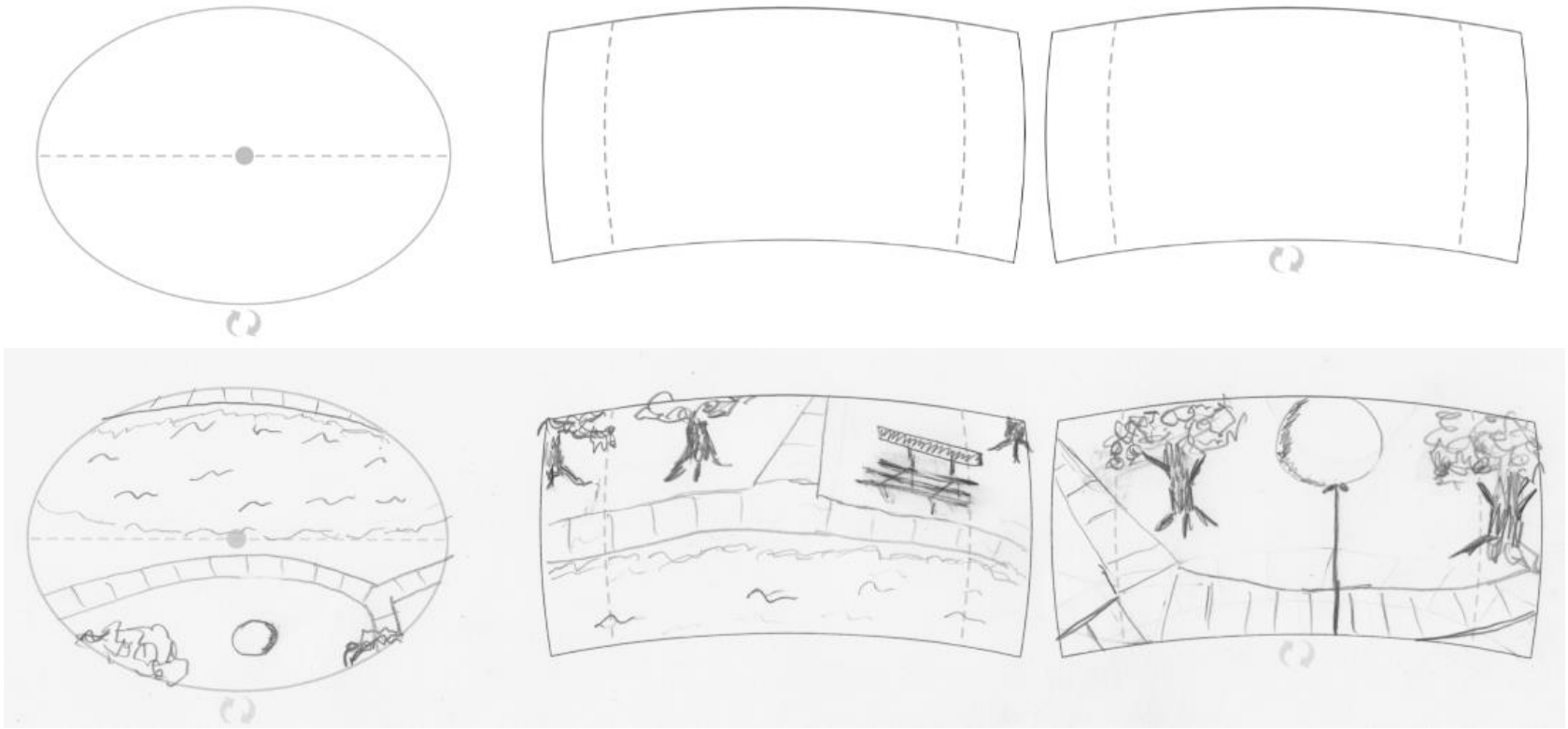
Priyaa Sathiyaseelan - https://priyaasathiyaseelan.com/portfolio/cook-simple-ar-app/

VR Storyboard Template

Concept Name: _____

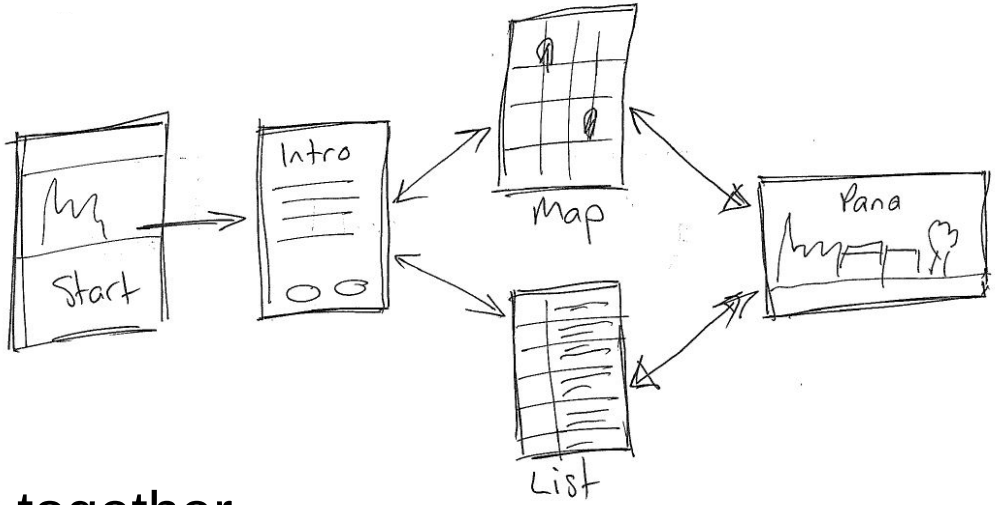


Example: VR Storyboard



https://medium.com/cinematicvr/a-storyboard-for-virtual-reality-fa000a9b4497

Wireframes

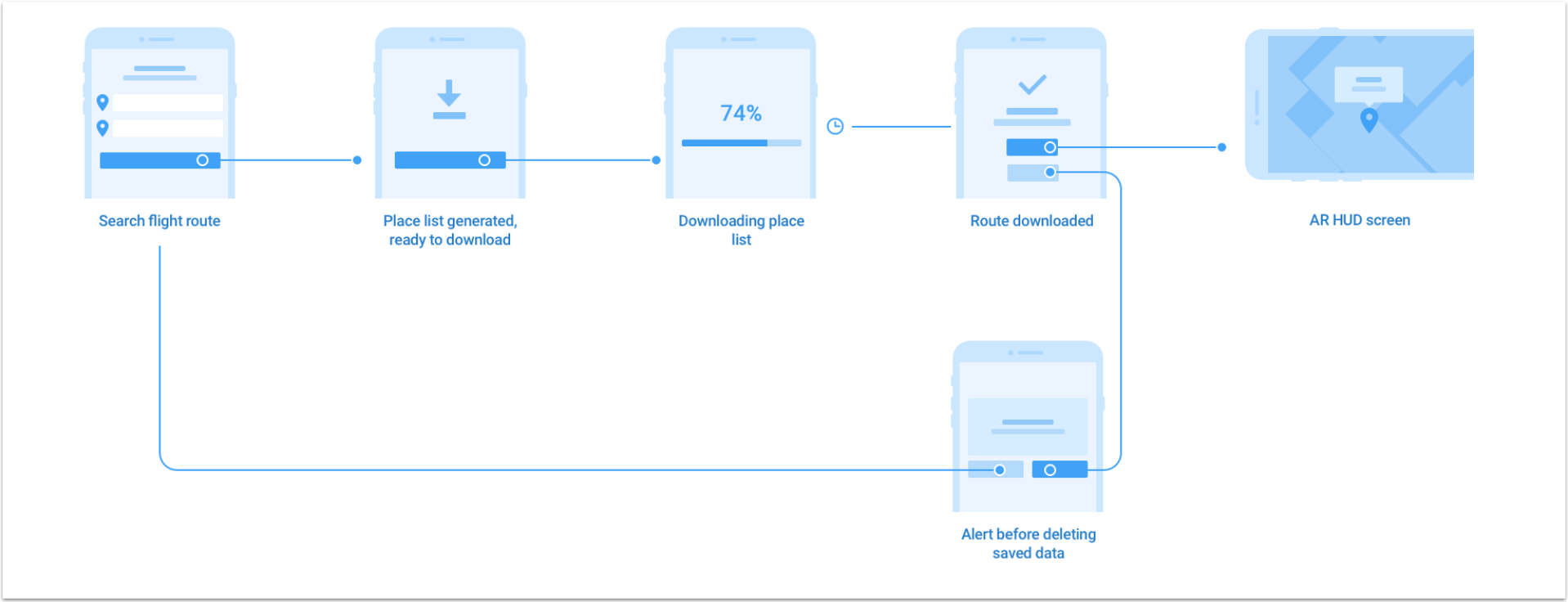


It's about

- Functional specs
- Navigation and interaction
- Functionality and layout
- How interface elements work together
- Defining the interaction flow/experience

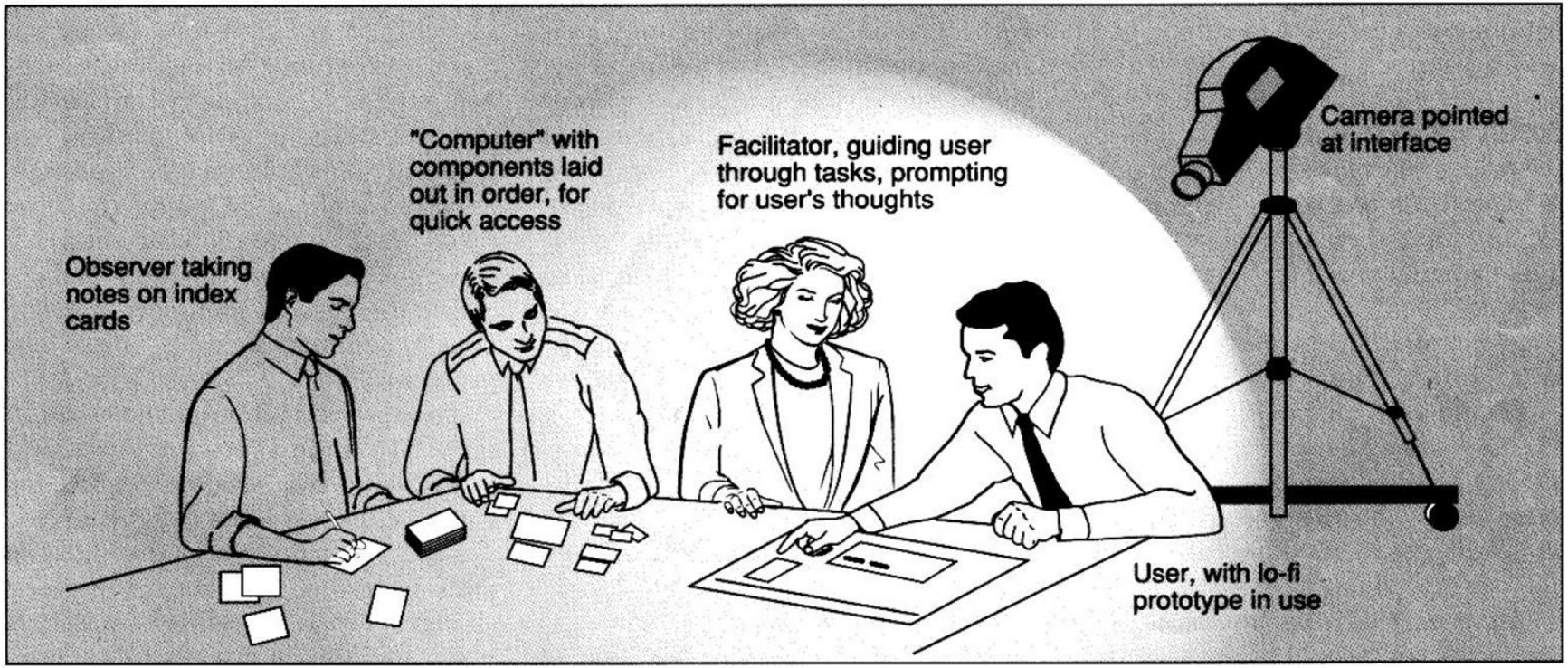
Leaving room for the design to be created

Example Wireframe



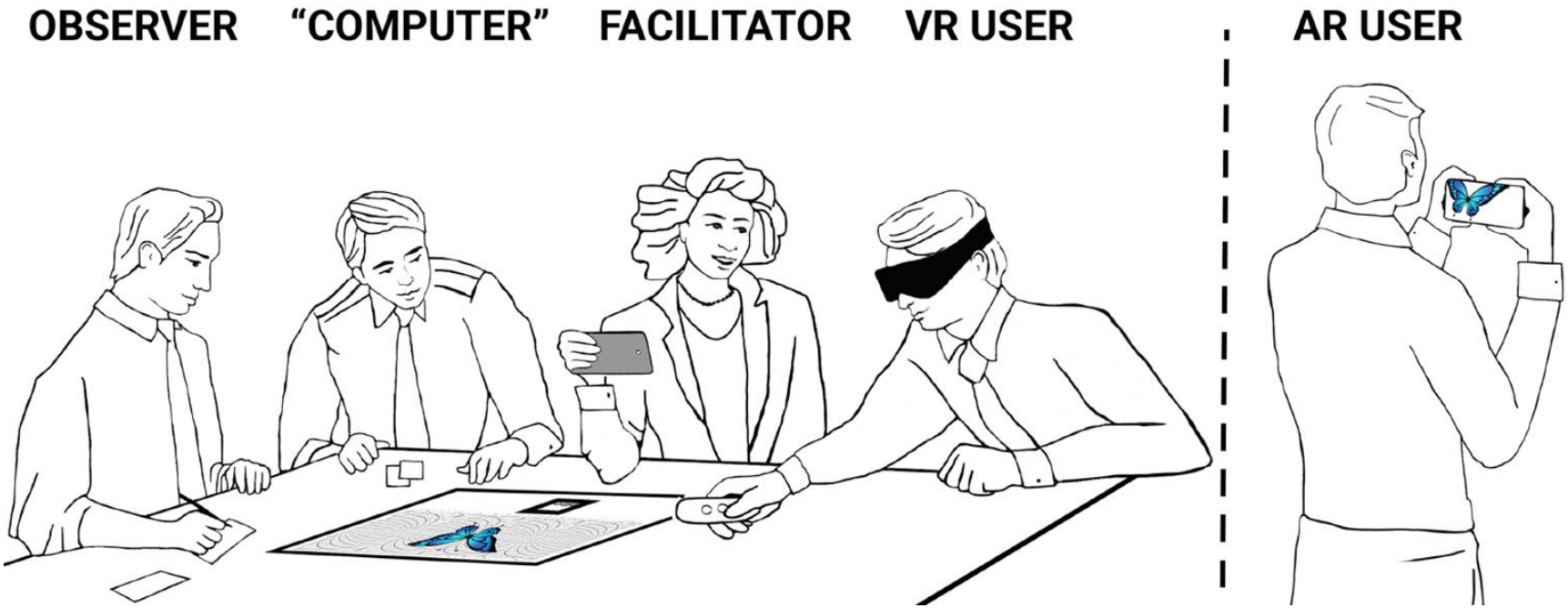
Chris Jacobs - https://blog.prototypr.io/making-flights-more-interesting-with-augmented-reality-322eecde827c

Paper Prototyping & Testing



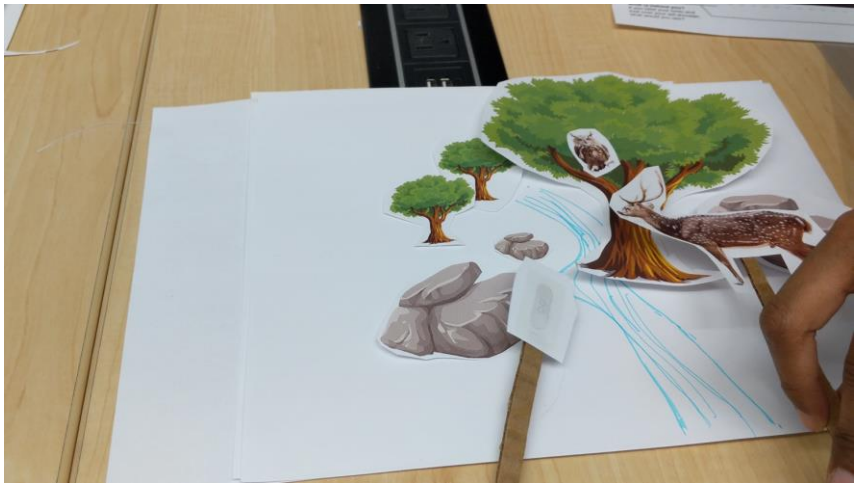
Rettig: *Prototyping for Tiny Fingers* (Comm. ACM 1994)

360 Paper Prototyping & Testing



Nebeling & Madier: *360proto: Making Interactive Virtual Reality & Augmented Reality Prototypes from Paper* (CHI 2019)

Paper Prototypes



- Bring storyboards to life
- Demonstrate interactions in front of the user
- Put objects on cardboard sticks or toothpicks to animate them

Nebeling & Madier: *360proto: Making Interactive Virtual Reality & Augmented Reality Prototypes from Paper* (CHI 2019)

360 Paper Prototypes

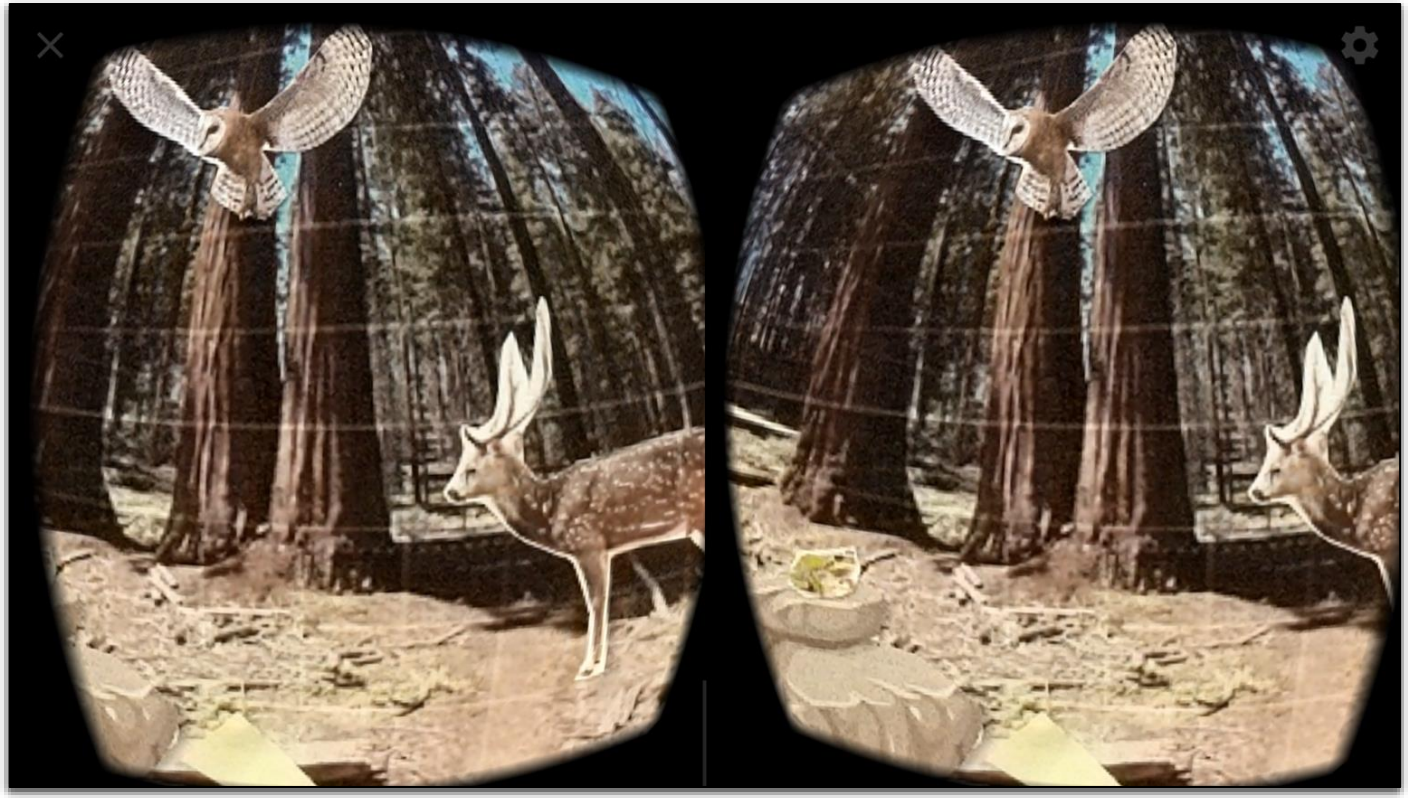
- Lay out content 360 degrees around the user
- Demonstrate interactions along the grid lines
- Use objects of different size to simulate depth

Nebeling & Madier: *360proto: Making Interactive Virtual Reality & Augmented Reality Prototypes from Paper* (CHI 2019)

360 Paper Prototype

Nebeling & Madier: *360proto: Making Interactive Virtual Reality & Augmented Reality Prototypes from Paper* (CHI 2019)

VR Previews



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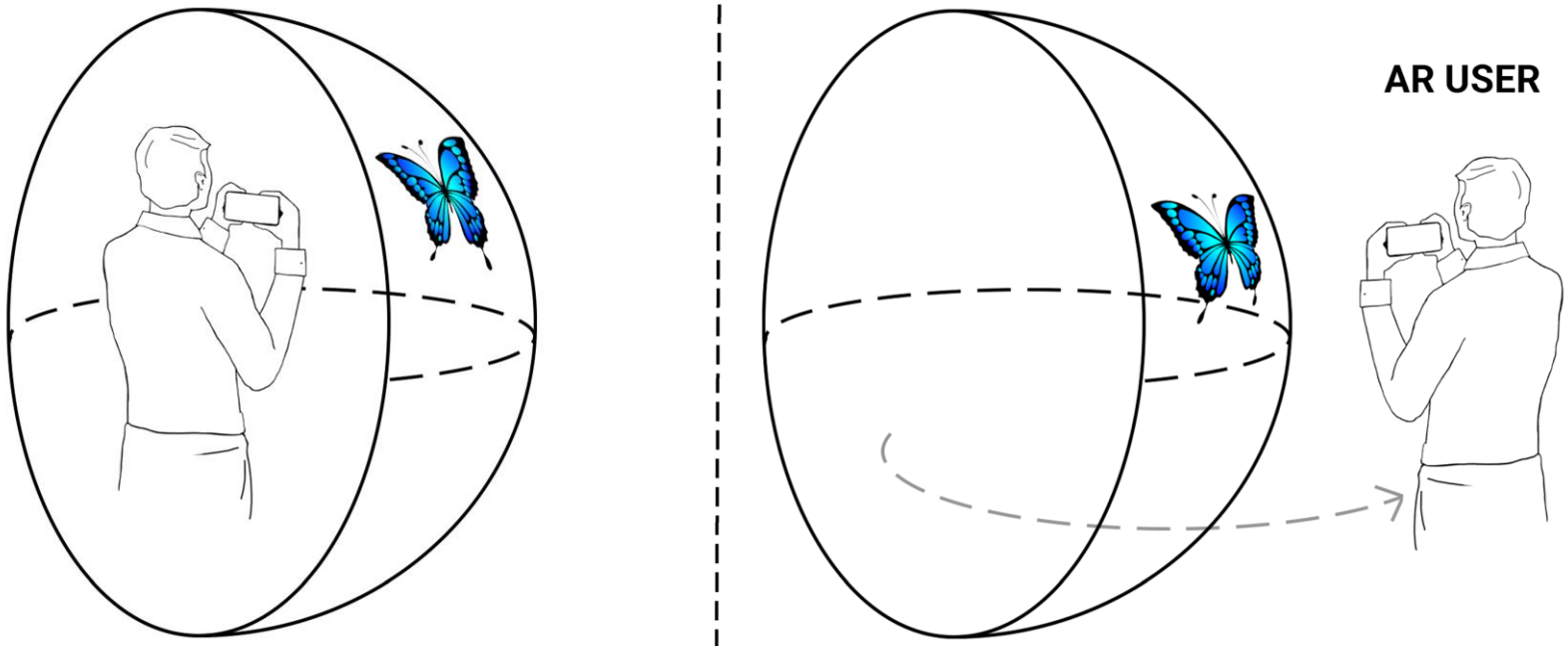
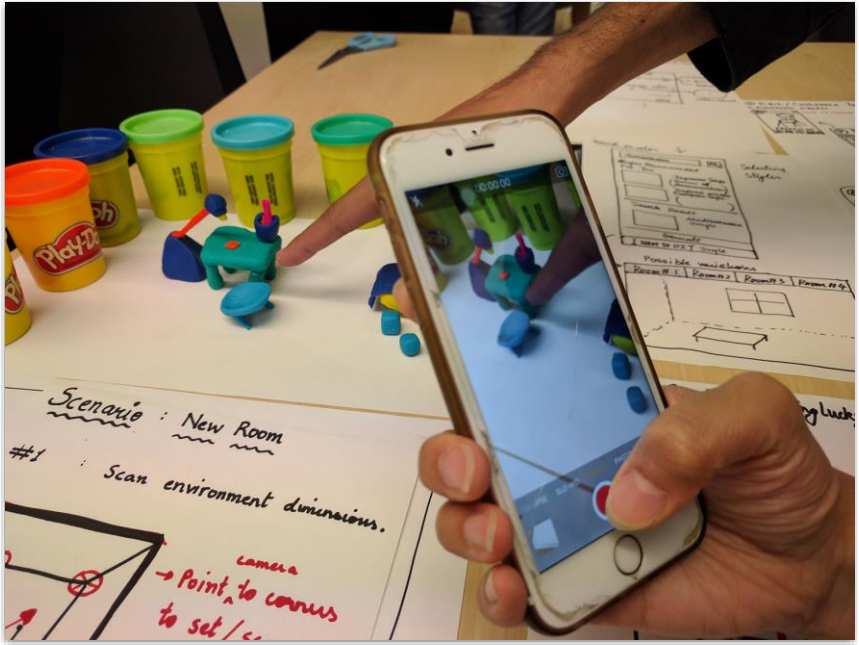
AR Previews



Nebeling & Madier: *360proto: Making Interactive Virtual Reality & Augmented Reality Prototypes from Paper* (CHI 2019)

3D Modeling with Clay



- Bring the 3D characters to live
- Get a sense of the complexity of 3D props
- Demonstrate interactions with respect to the 3D models

Nebeling et al.: *ProtoAR: Rapid Physical-Digital Prototyping of Mobile Augmented Reality Applications* (CHI 2018)

3D Modeling with Clay

Nebeling et al.: *ProtoAR: Rapid Physical-Digital Prototyping of Mobile Augmented Reality Applications* (CHI 2018)

Diorama

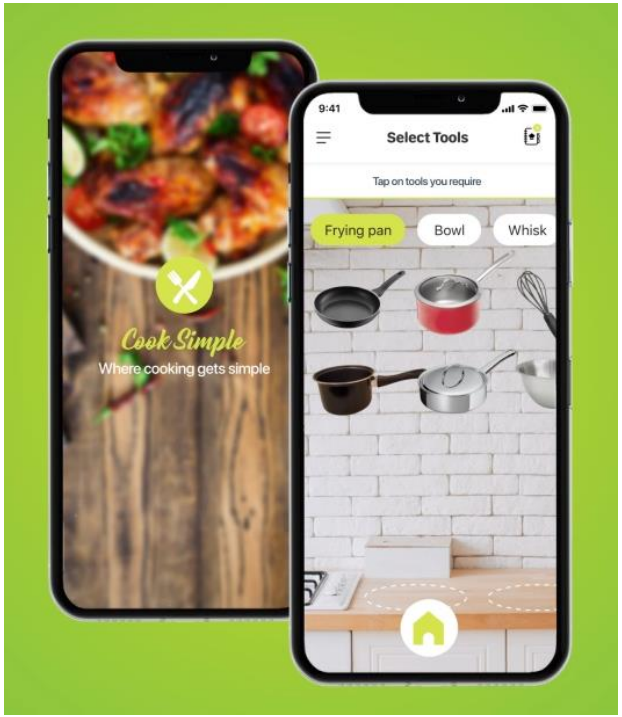
- Enact the 3D scene in the physical world
- Play out the 3D characters in response to user interactions
- Gauge spatial requirements and understand relationships

Nebeling & Madier: *360proto: Making Interactive Virtual Reality & Augmented Reality Prototypes from Paper* (CHI 2019)

Mockup

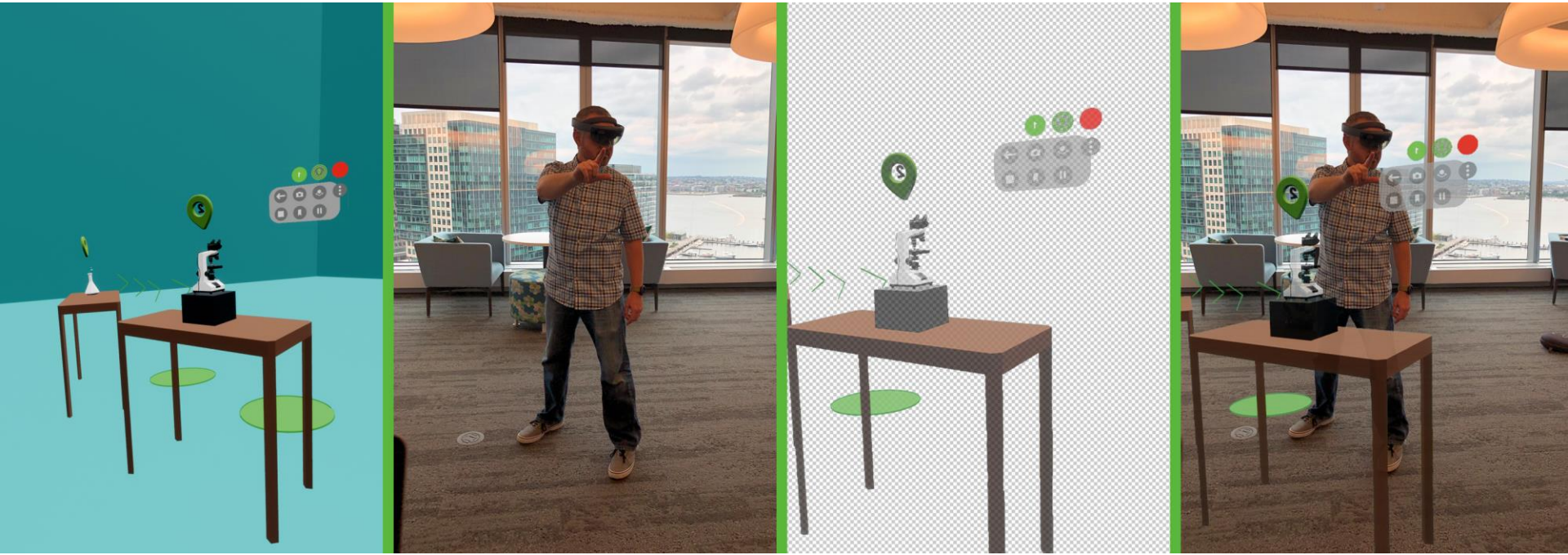
It’s about

- Look and feel
- Building on wireframe
- High fidelity visuals
- Putting together final assets
- Getting feedback on design



Priyaa Sathiyaseelan - https://priyaasathiyaseelan.com/portfolio/cook-simple-ar-app/

AR Mockup



Combining 3D graphics with photo background

https://medium.com/@dylanhongtech/augmented-reality-prototyping-tools-for-head-mounted-displays-c1ee8eaa0783

Sketching in VR

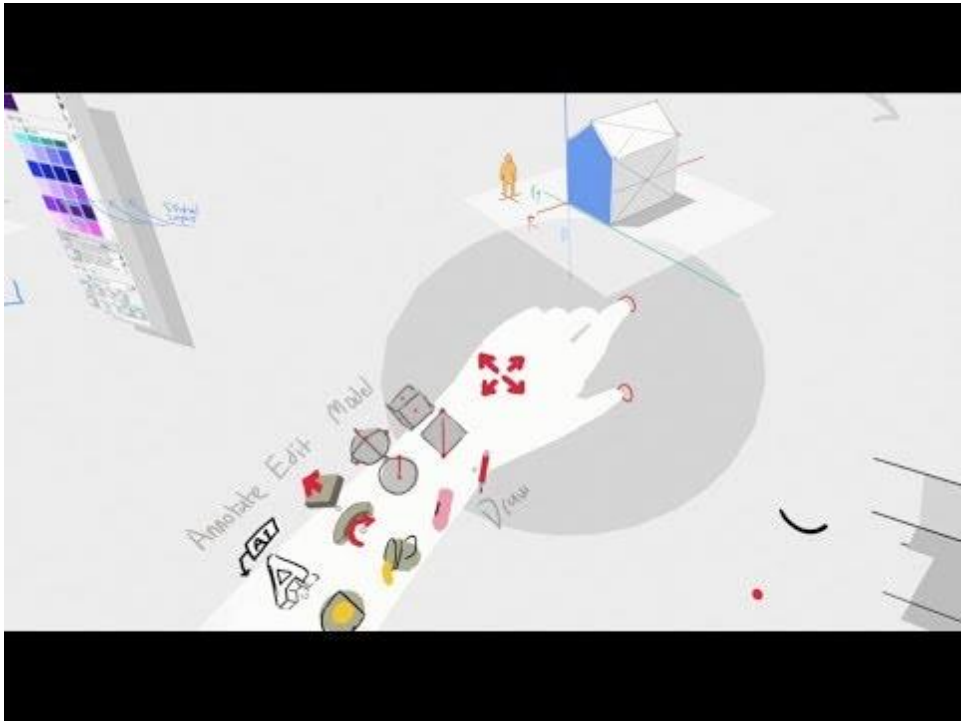
Using VR applications for rapid prototyping

- Intuitive sketching in immersive space
- Creating/testing at 1:1 scale
- Rapid UI design/layout

Examples

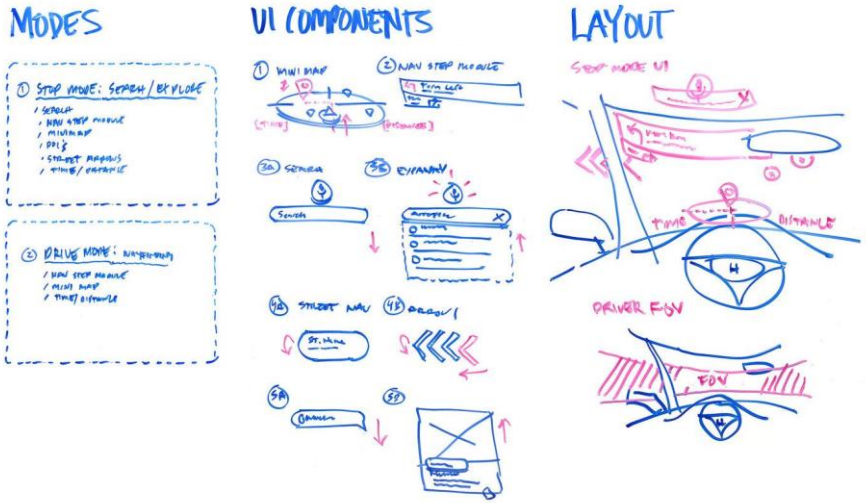
- Quill - https://quill.fb.com/
- Tilt Brush - https://www.tiltbrush.com/

Example: VR Concept Interface for SketchUp



https://www.youtube.com/watch?v=5FR3BLkgSPk

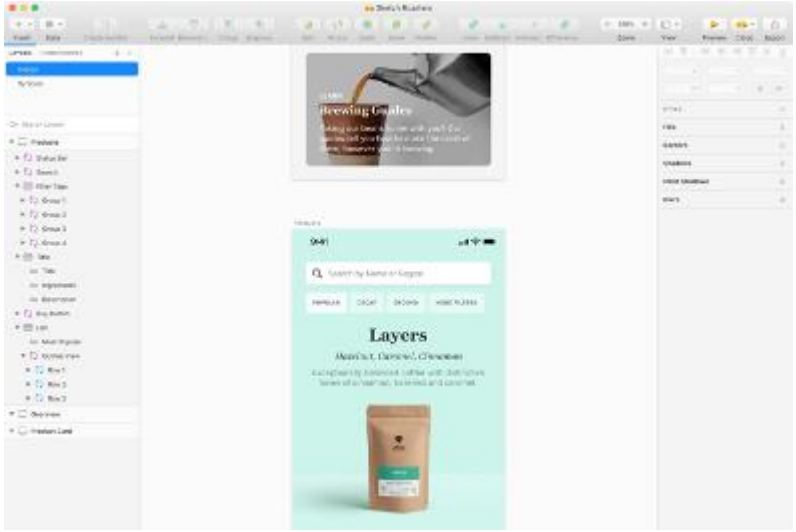
Designing AR in VR



https://www.youtube.com/watch?v=TfQJhSJQiaU

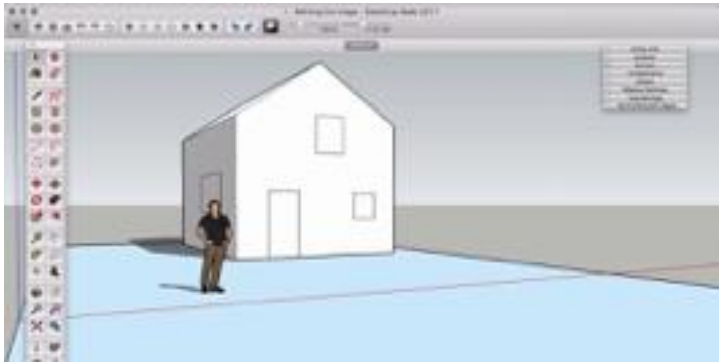
2D Asset Creation

- Many possible tools
  - Sketch
    - MacOS
    - https://www.sketch.com/
  - Figma
    - Chrome plugin
    - https://www.figma.com/

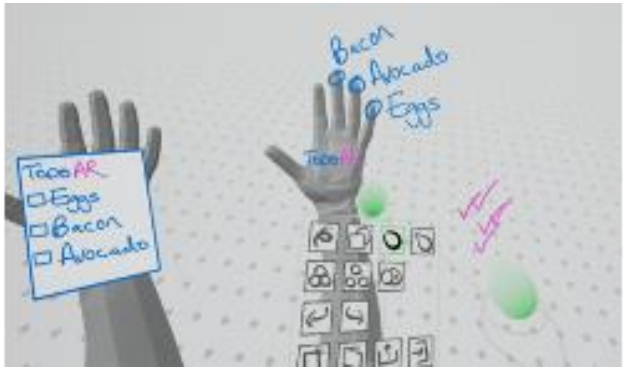


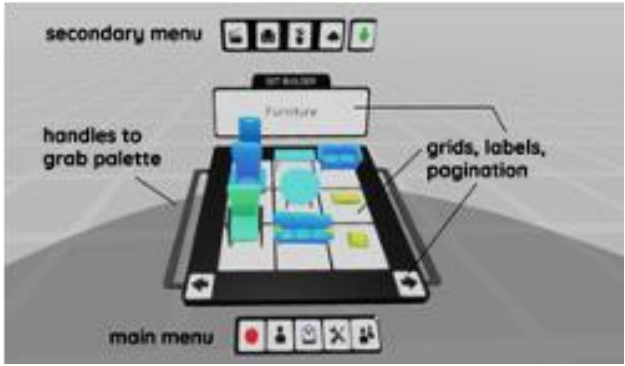
3D Asset Creation

- Use public 3D assets
  - Sketchfab - https://sketchfab.com/
    - Web-based 3D model library
  - Poly - https://poly.google.com/
    - Low polygon models for AR/VR
- Build 3D assets
  - Sketchup - https://www.sketchup.com/
    - Easy 3D modelling
  - Gravity Sketch - https://www.gravitysketch.com/
    - Model creation from sketching/CAD
  - Google Blocks - https://arvr.google.com/blocks/
    - Model in VR
  - Blender - https://www.blender.org/
    - Open source CAD modelling



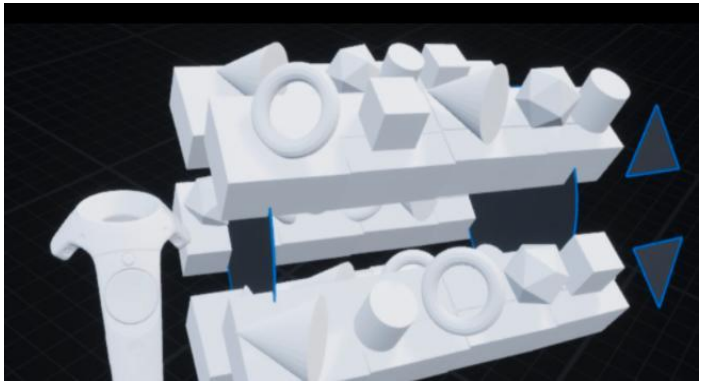
3D Scene Layout

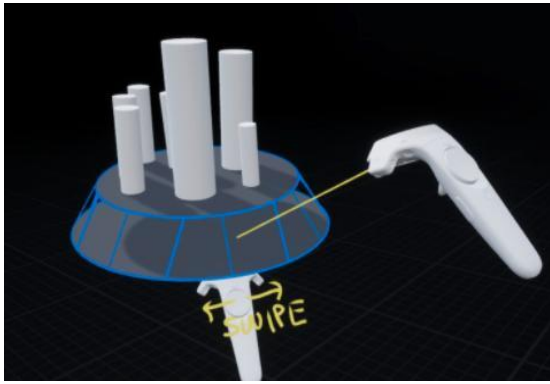




- Scene layout in VR
  - Sketchbox
    - https://www.sketchbox3d.com/
    - Fast and simple VR prototyping tool
    - Collaborative VR design tool
    - Export to SketchFab/fbx

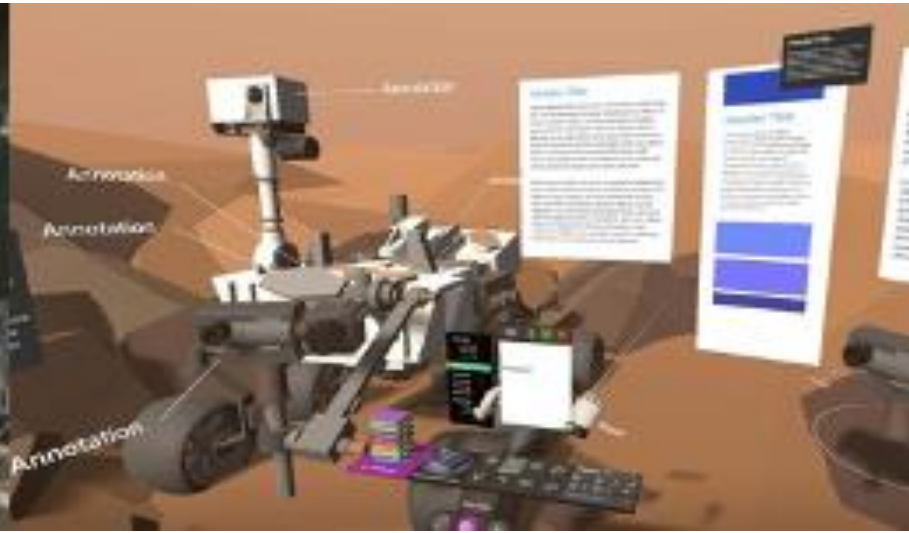
Scene Assembly





- Assemble assets into 3D scene
  - Prototype final UI concept
  - Create high-fidelity view
  - Collect user feedback
- Immersive Scene Assembly
  - Microsoft Maquette: https://www.maquette.ms/
  - Sketchbox: https://www.sketchbox3d.com/

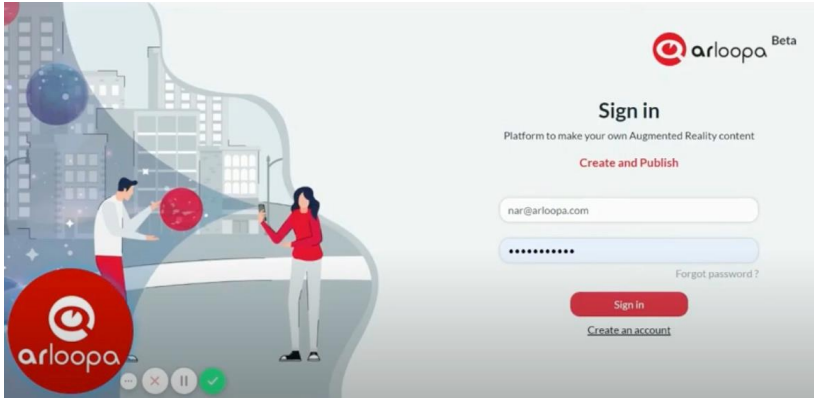
Microsoft Maquette



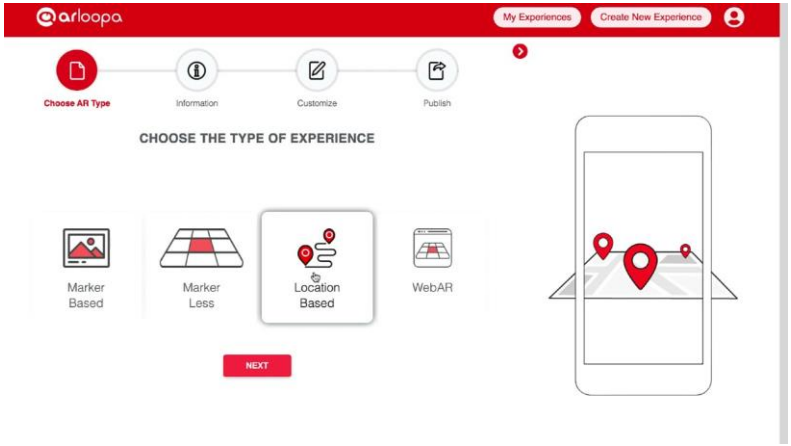
- Prototype VR interfaces from inside VR
- 3D UI for spatial prototyping
- Bring content into Unity with plug-in
- Javascript support
- https://www.maquette.ms/

Scene Assembly In AR

- Many tools for creating AR scenes
  - Drag and drop your assets
  - Develop on web, publish to mobile
- Examples
  - Catchoom - CraftAR
  - Blippar - Blipbuilder
  - ARloopa - ARloopa studio
  - Wikitude - Wikitude studio
  - Zappar - ZapWorks Designer



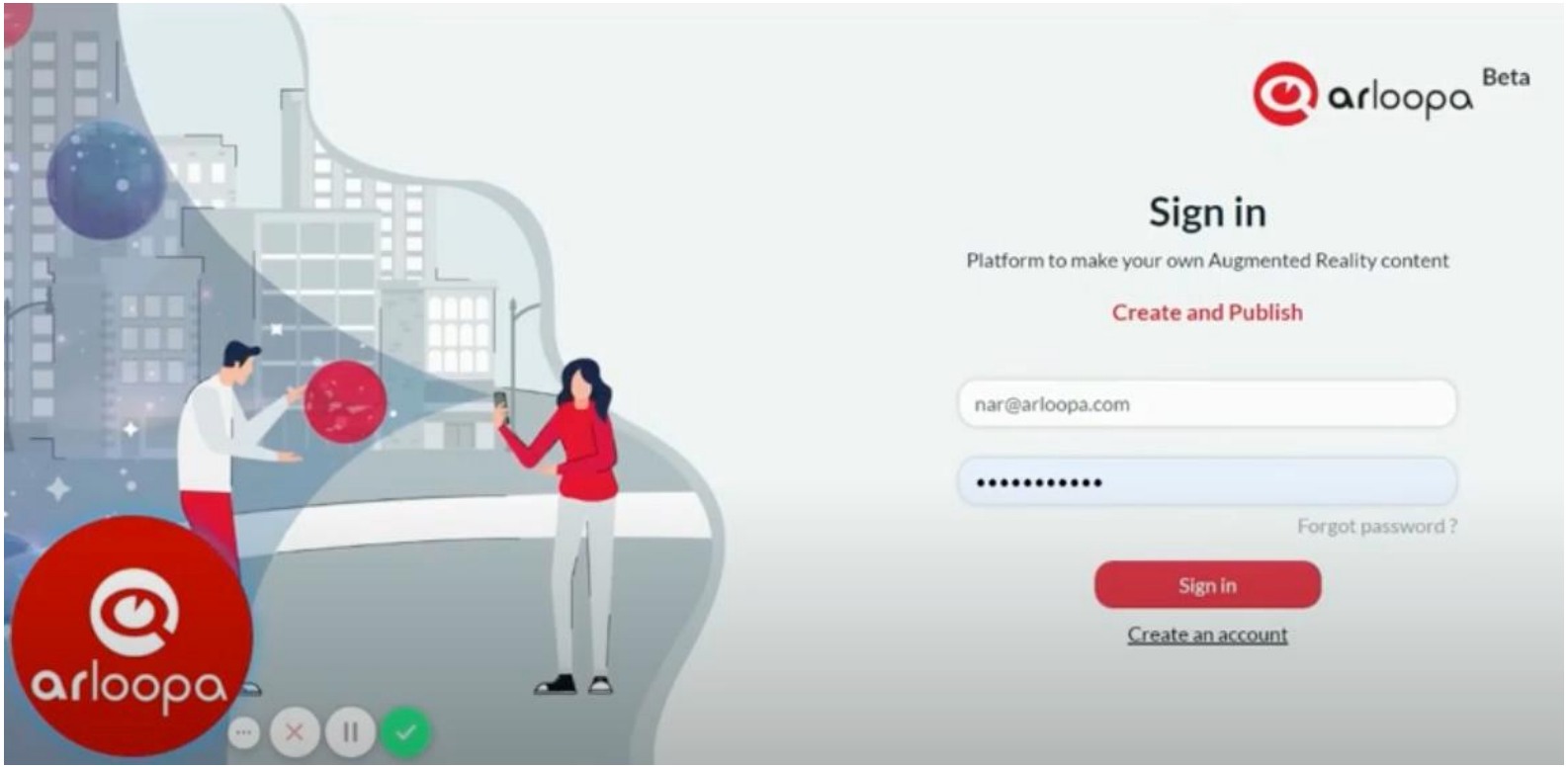
ARLoopa Studio



Web-based AR authoring

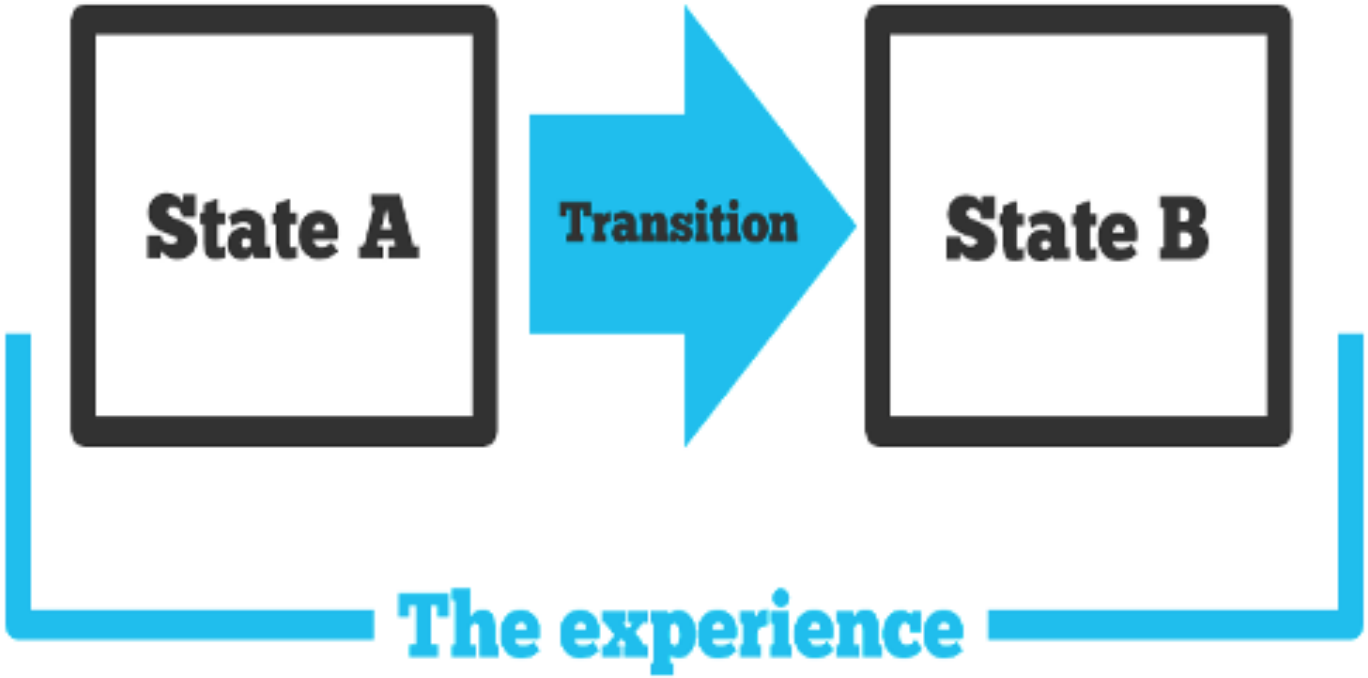
- Add 3D models, video, images to real print content
- Simple drag and drop interface
- Marker image recognition, markerless tracking
- https://arloopa.com/

Example ARLoopa Studio



https://www.youtube.com/watch?v=gJ5FZ9IVdQ4

Adding Transitions



Video Sketching

"Unless you can show me where you've fleshed out the character and aspects of the transitions at the same level of … fidelity as you have the states – you're fired."

Bill Buxton

Video Sketching

- Process
  - Capture elements of real world
  - Use series of still photos/sketches in a movie format.
  - Act out using the product
- Benefits
  - Demonstrates the product experience
  - Discover where concept needs fleshing out.
  - Communicate experience and interface
  - You can use whatever tools you want, e.g. iMovie.

Google Glass Concept Movie

https://www.youtube.com/watch?v=5R1snVxGNVs

Tvori - Animating VR Interfaces

- Animation based VR prototyping tool
  - https://tvori.co/
- Key features
  - Model input, animation, etc
  - Export 360 images and video
  - Simulate AR views
  - Multi-user support
  - Present in VR
  - Create VR executable

Low Fidelity Prototyping Process

1. Collect tools needed
2. Know/imagine the user
3. Storyboard/sketch the experience
4. Create assets needed
5. Create the interface scenes
6. View in VR/record video

Case Study

Mobile AR for Spatial Navigation

From Sharon Brosnan
BS in Digital Media Design
Final Project

Bunratty Folk Park

AR Navigational Aid for Bunratty

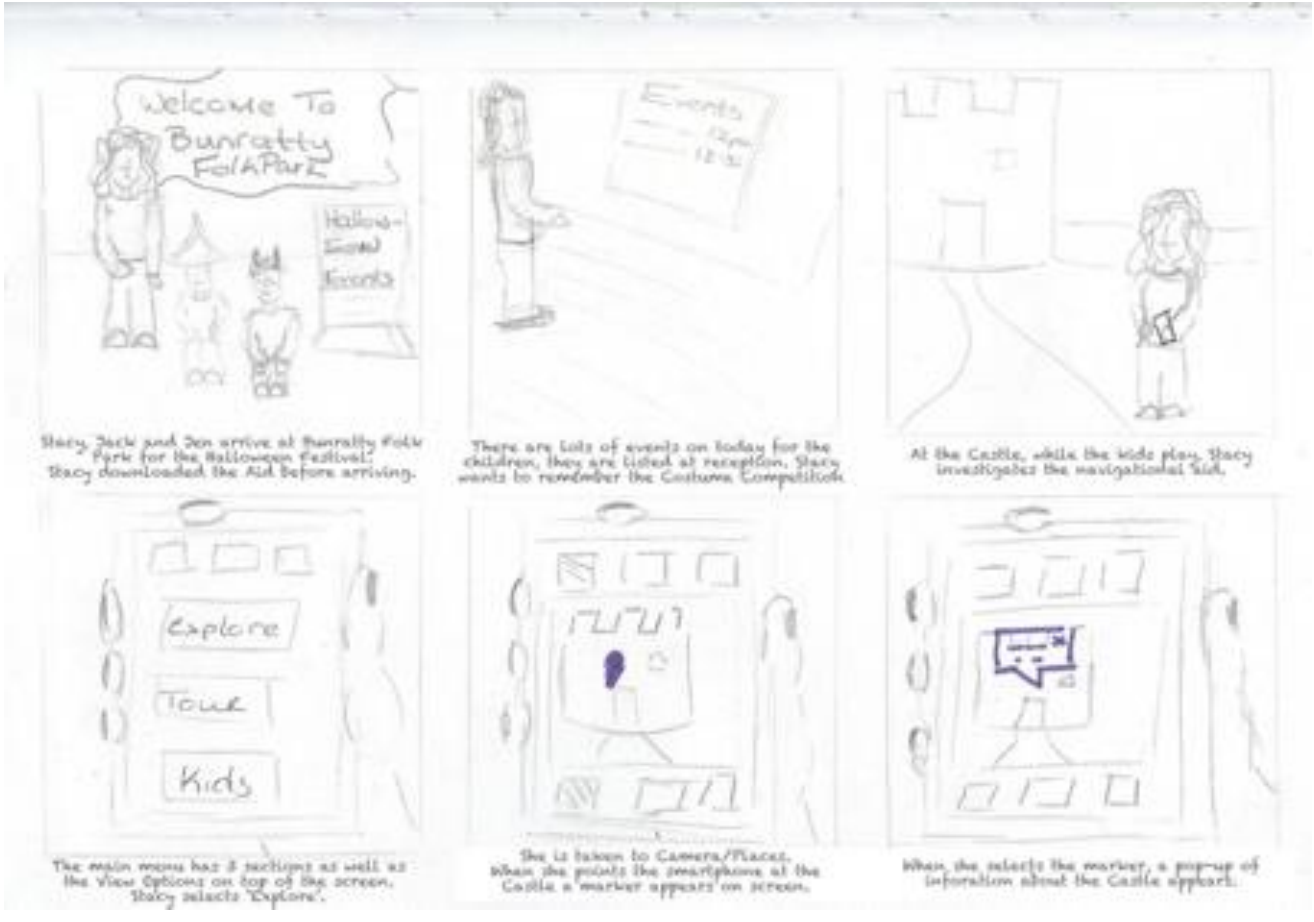
Goal of the Navigational Aid

- Easy to use, clear and understandable
- Useful to visitors
- Creating interaction between the visitor and the aid through the user interface
- Engage the visitor

To ensure this…

- It is necessary to understand the visitor of a navigational aid in Bunratty Folk Park
- Identify visitor motives and goals while going through the Folk Park.

Storyboard


Welcome To Bunratty FolkPark
Hallow-e'en Events
Explore
Tour
Kids
Stacy, Jack and Jen arrive at Bunratty Folk Park for the Halloween Festival. Stacy downloaded the Aid before arriving.
There are lots of events on today for the children, they are listed at reception. Stacy wants to remember the Costume Competition
At the Castle, while the kids play, Stacy investigates the navigational Aid.
The main menu has 3 sections as well as the View Options on top of the screen. Stacy selects 'Explore'.
She is taken to Camera/Places. When she points the smartphone at the Castle a marker appears on screen.
When she selects the marker, a pop-up of information about the Castle appears.

Sketch Interfaces (Photoshop)

Pros:

- Good for idea generation
- Cheap
- Concepts seem feasible

Cons:

- Not great feedback gained
- Photoshop not fast enough for making changes

Post-it Prototyping

Camera View with 3D

First Draft

Second

- Selection highlighted in blue

Third Draft

- Home button added for easy navigation to main menu

Powerpoint Prototyping

Benefits

- Used for User Testing
- Interactive
- Functionalities work when following the story of Scenario 1
- Quick
- Easy arrangement of slides

User Testing

- Participants found
- 15 minute sessions screen captured
- 'Talk Allowed' technique used
- Notes taken
- Post-Interview

Wikitude Interface

- Popular augmented reality browser for mobile devices
- Mapping
- Point of Interest abilities
- Multiplatform
- Shows the points of interest of Bunratty Folk Park
  - Markers can be selected in and an information pop-up appears

Final Video Prototype

- Flexible tool for capturing the use of an interface
- Elaborate simulation of how the navigational aid will work
- Does not need to be realistic in every detail
- Gives a good idea of how the finished system will work

Case Study: HMD AR Prototype

https://medium.com/@dylanhongtech/augmented-reality-prototyping-tools-for-head-mounted-displays-c1ee8eaa0783

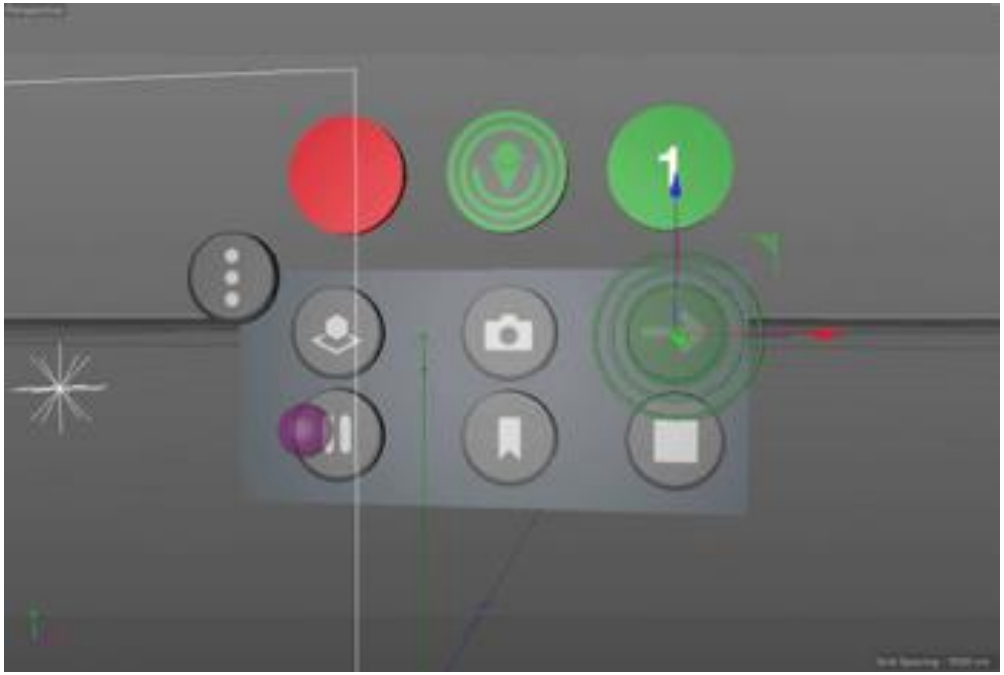
AR Prototyping for HMDs

- Tools
  - Storyboarding - Concept
  - Sketch – high fidelity 2D
  - Cinema4D – 3D animation
  - SketchBox – 3D layout
  - Photoshop – Visual mockup
  - PowerPoint - Interactivity

Sketch Design

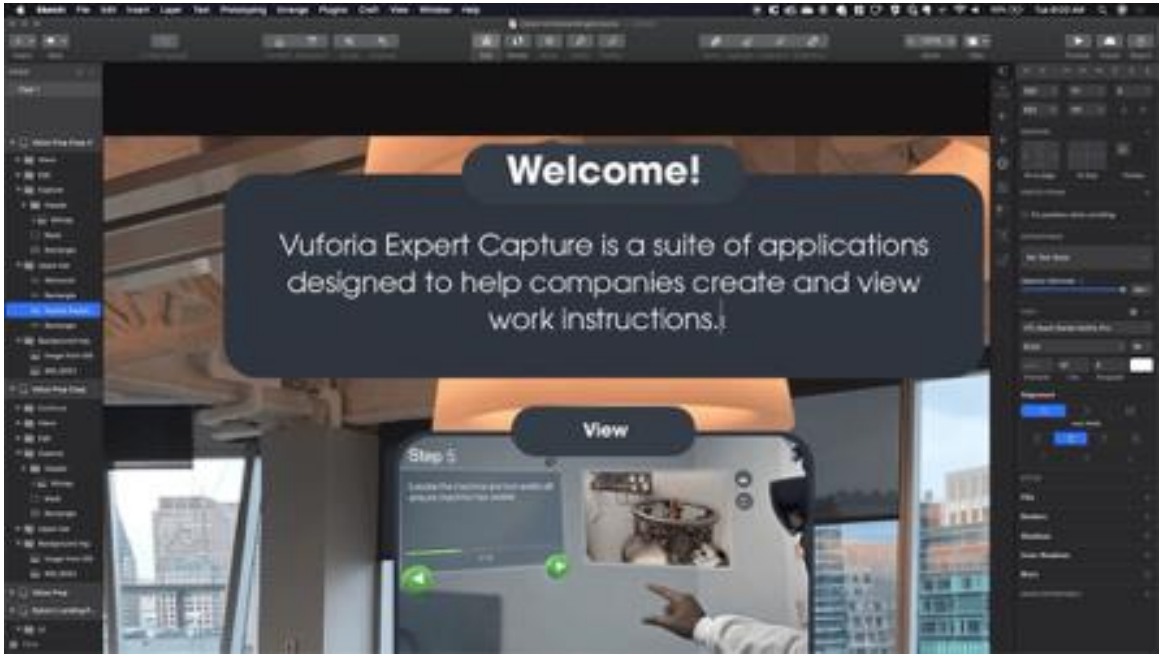
- User Interface Layout
- Overlay AR elements on blurry background

Cinema4D



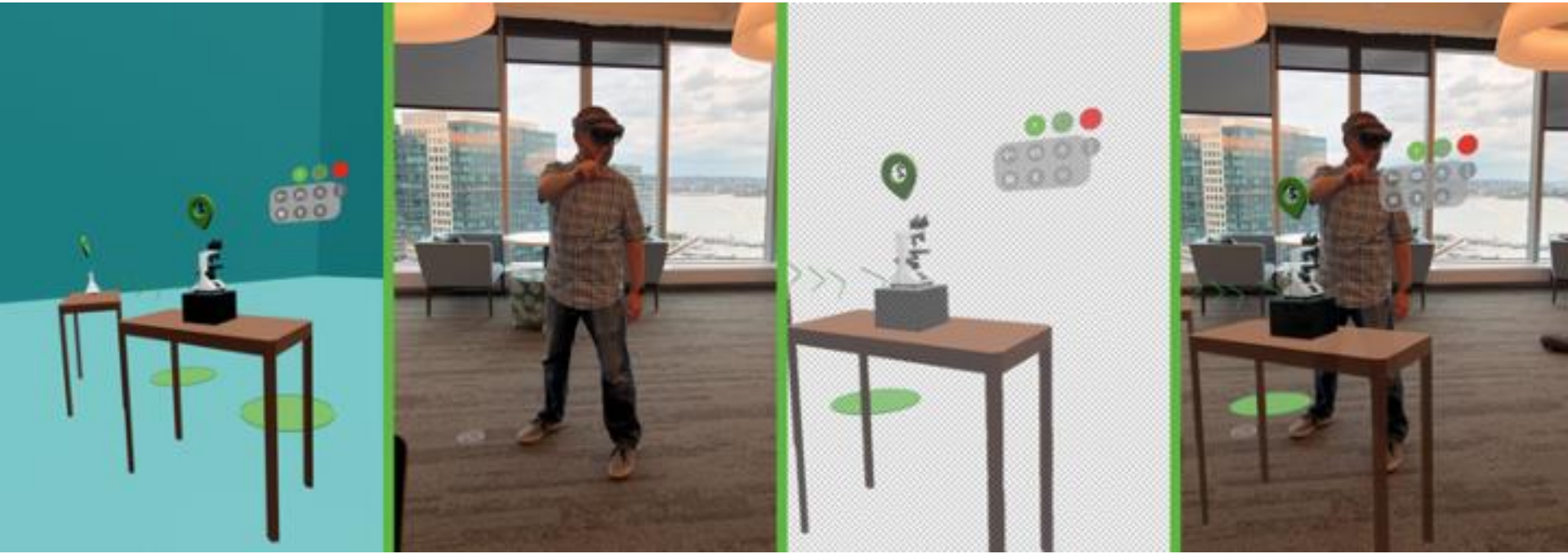
- 3D animation tool
- Interface element mock-up

SketchBox



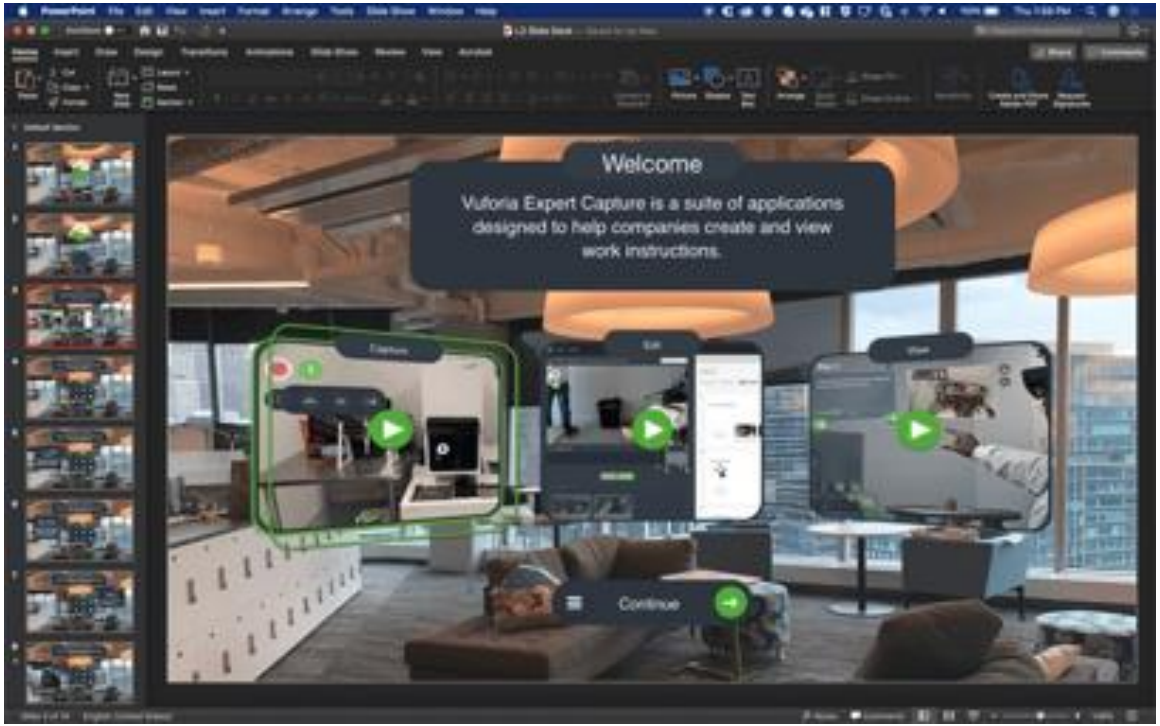
- 3D user interface layout

Photoshop



- High end visual mock-ups
- Add AR content to real world views

Final PowerPoint Prototype



- Simple interactive demo

High Fidelity Tools

XR Prototyping Tools

Low Fidelity (Concept, visual design)

- Sketching
- Storyboarding & wireframes
- Mockups
- Paper & video prototyping

High Fidelity (Interaction, experience design)

- Interactive sketching
- Desktop & on-device authoring
- Immersive authoring & visual scripting
- XR development toolkits

XR Tools Landscape

Digital & Immersive Authoring

Proto.io, Tour Creator, ...

Tilt Brush, Blocks, Quill, …

Cross-Platform Development

Unity + SDKs

Unreal + SDKs

Web-Based Development

THREE.js, Babylon.js, …

A-Frame, AR.js, …

Native Development

Cardboard/Oculus/Vive/… SDK

Vuforia/ARCore/ARKit/… SDK

XR Tools Landscape

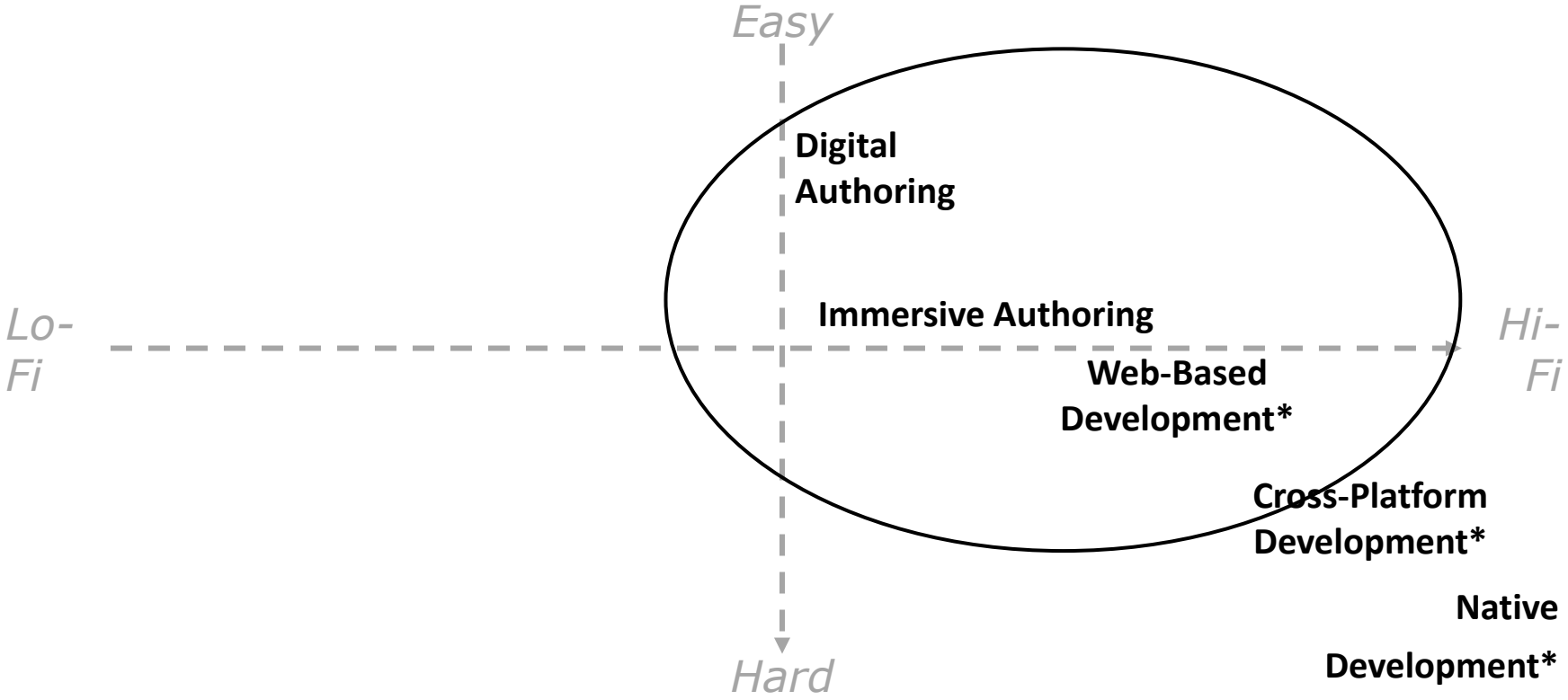
Digital & Immersive Authoring
Good for storyboarding but limited support for interactions

Cross-Platform Development
Good for full-fledged XR apps but usually high learning curve

Web-Based Development
Good for basic XR apps but often interactions feel unfinished

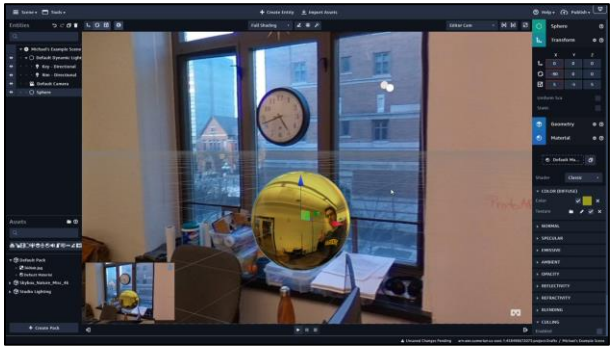
Native Development
Good for full-fledged XR apps but limited to a particular platform

Digital Prototyping



** requires scripting and 3D programming skills*

Digital Authoring Tools for VR

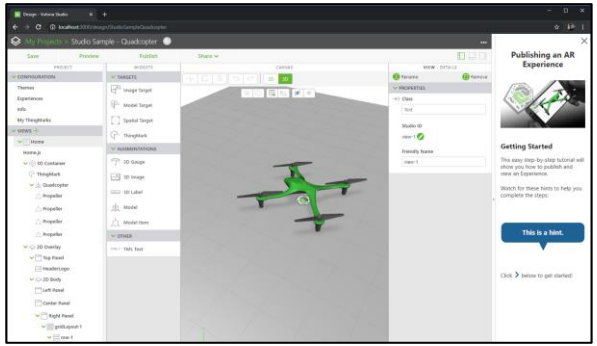


Amazon Sumerian

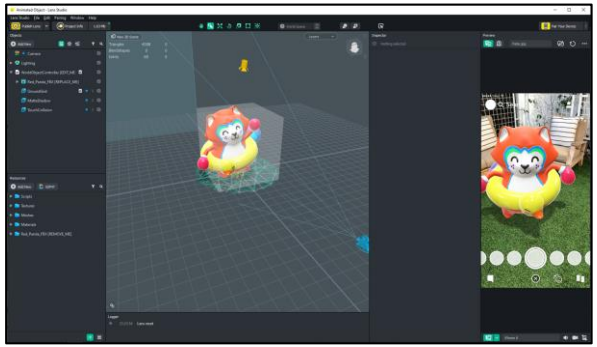
Unity Editor

- Support visual authoring of 3D scene graphs with VR previews
- Basic interactions can be implemented without coding
- Advanced interactions require JavaScript, C#, or C++

Digital Authoring Tools for AR



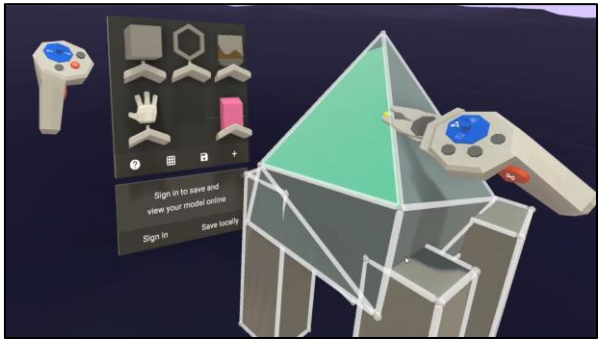
Vuforia Studio



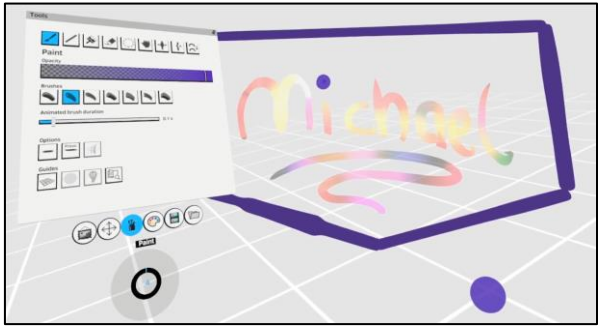
Lens Studio

- Support visual authoring of marker-based and/or marker-less AR apps
- Provide default markers and support for custom markers
- Typically enable AR previews through emulator but need to deploy to AR device for testing

Immersive Authoring Tools for VR



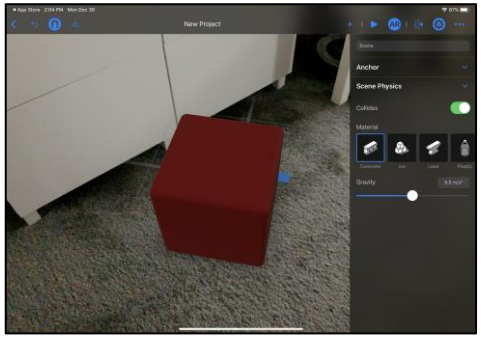
Google Blocks



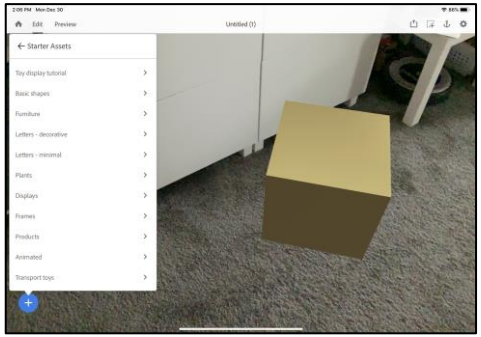
Oculus Quill

- Enable visual authoring of 3D content in VR
- Make it possible to edit while previewing VR experience
- Focus on 3D modeling rather than animation & scripting
- Typically support export to common 3D model formats and asset sharing platforms like Google Poly, Sketchfab, or 3D Warehouse

Immersive Authoring Tools for AR



Apple Reality Composer



Adobe Aero

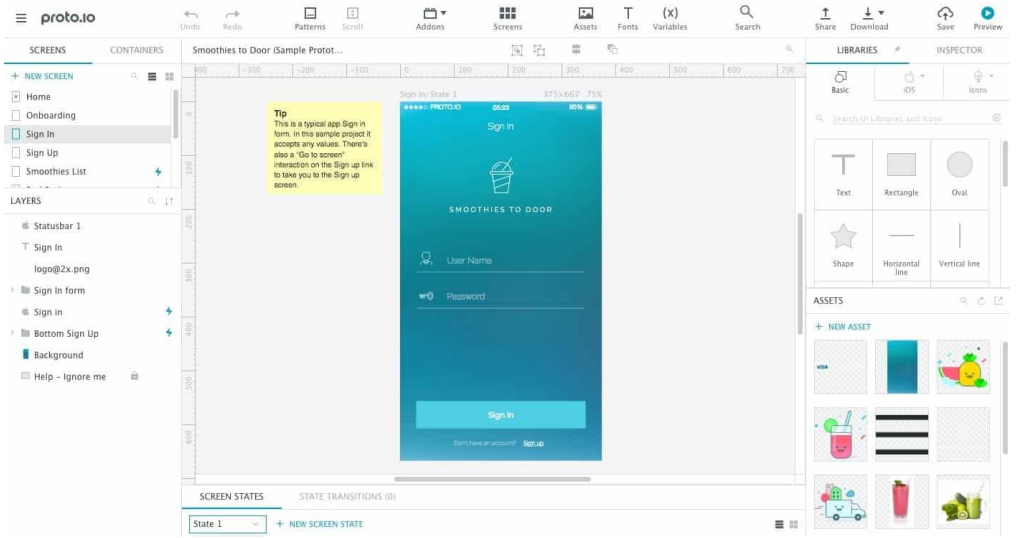
- Enable visual authoring of 3D content in AR
- Make it possible to edit while previewing AR experience in the environment
- Provide basic support for interactive behaviors
- Sometimes support export to WebXR

Interactive Sketching

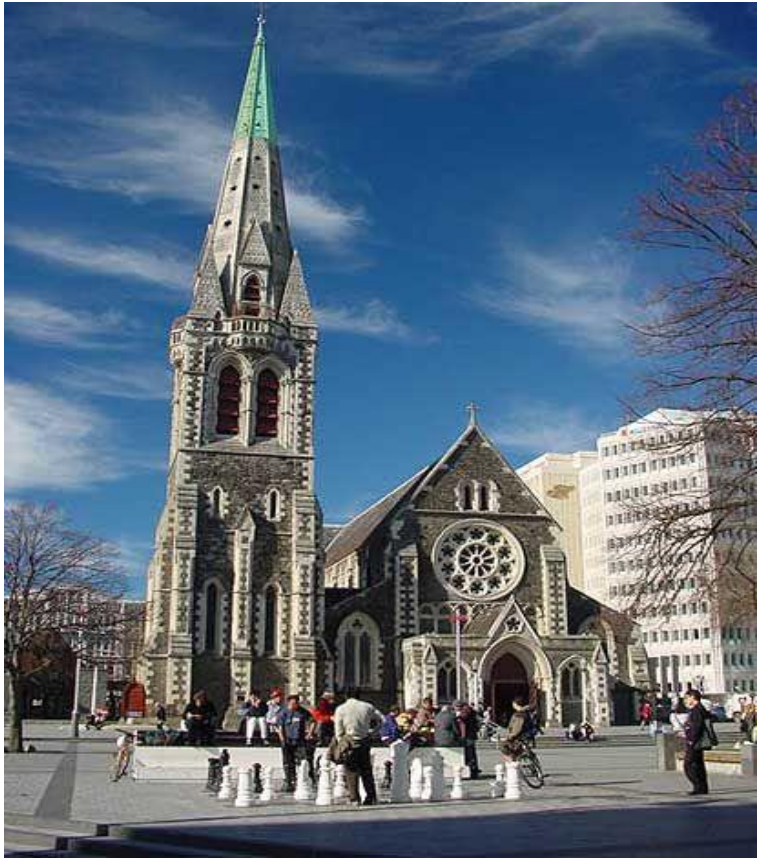
- Pop App
  - Pop - https://marvelapp.com/pop
  - Combining sketching and interactivity on mobiles
  - Take pictures of sketches, link pictures together

Proto.io

- Web based prototyping tool
  - Visual drag and drop interface
- Rich transitions
  - Scroll, swipe, buttons, etc
- Deploy on device
  - mobile, PC, browser
- Ideal for mobile interfaces
  - iOS, Android template
- For low and high fidelity prototypes



Case Study: CityViewAR (2021)



February 2011

CityViewAR Application

Goal: Create a mobile app that allowed people to view immersive panoramas on site, showing the 2011 damage

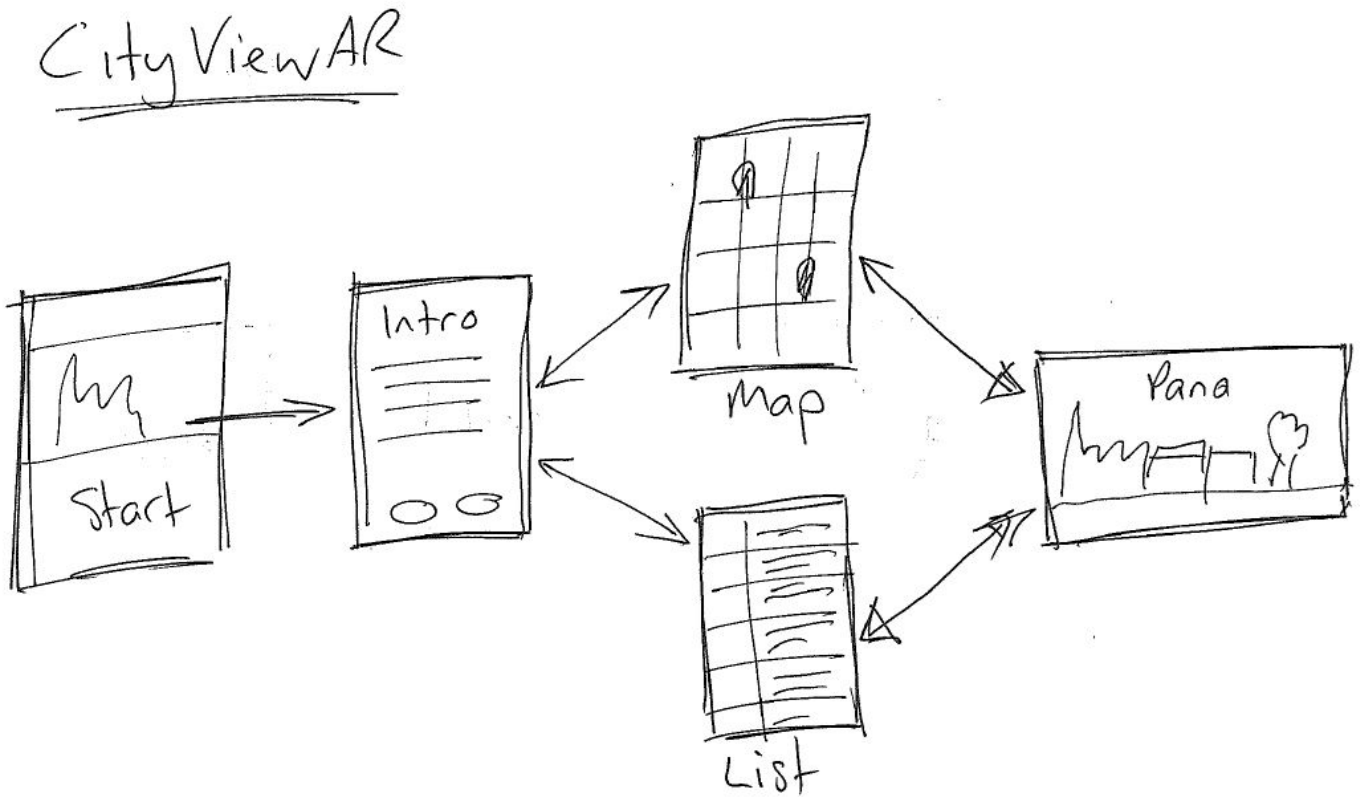
Key technology: Mobile phone, GPS, 360 panorama, map

User Experience: People walking the city streets will be able to be immersed in the earthquake damage from 10 years ago

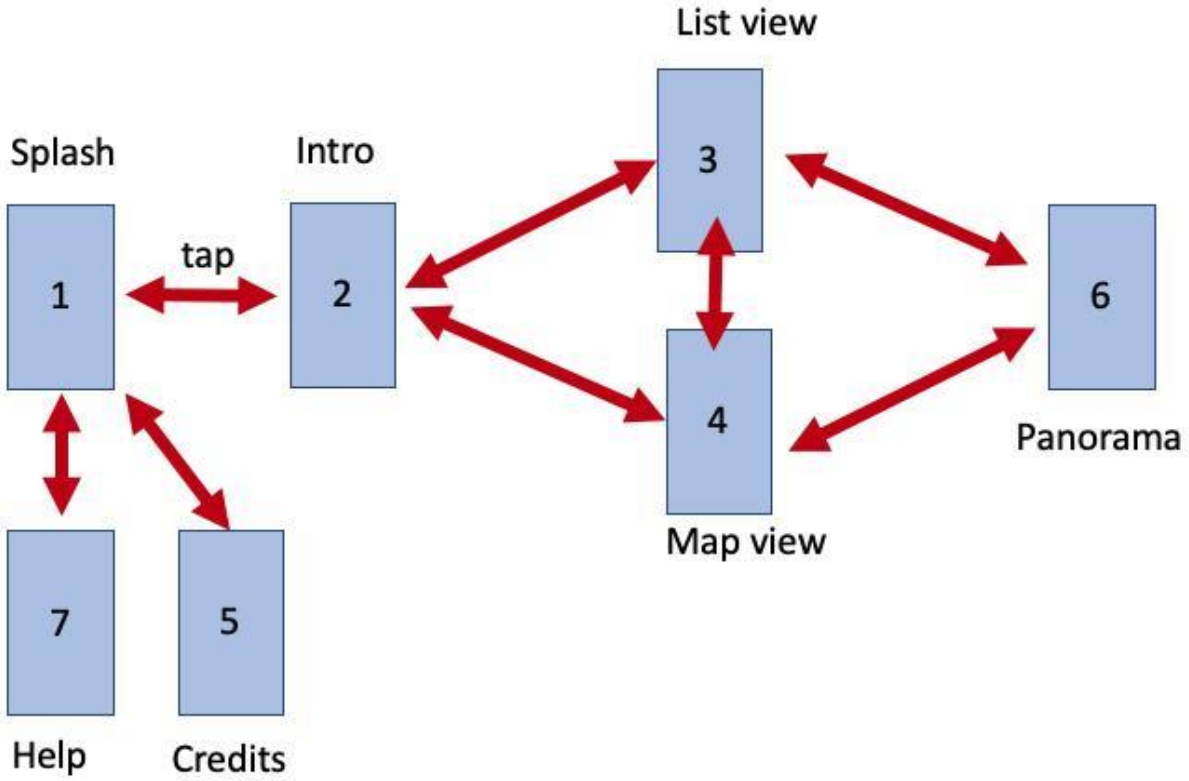
CityViewAR Prototyping Process

1. Sketch Interaction Flow (Paper)
2. Create Wireframe (Powerpoint)
3. Sketch Screens (Paper)
4. Test Transitions (Pop)
5. Collect/Create Assets (Photoshop, various)
6. Create High Fidelity Prototype (Proto.io)
7. Code (Unity, Mapbox)
8. Make video demo (Various)
9. Publish (Android, iOS)

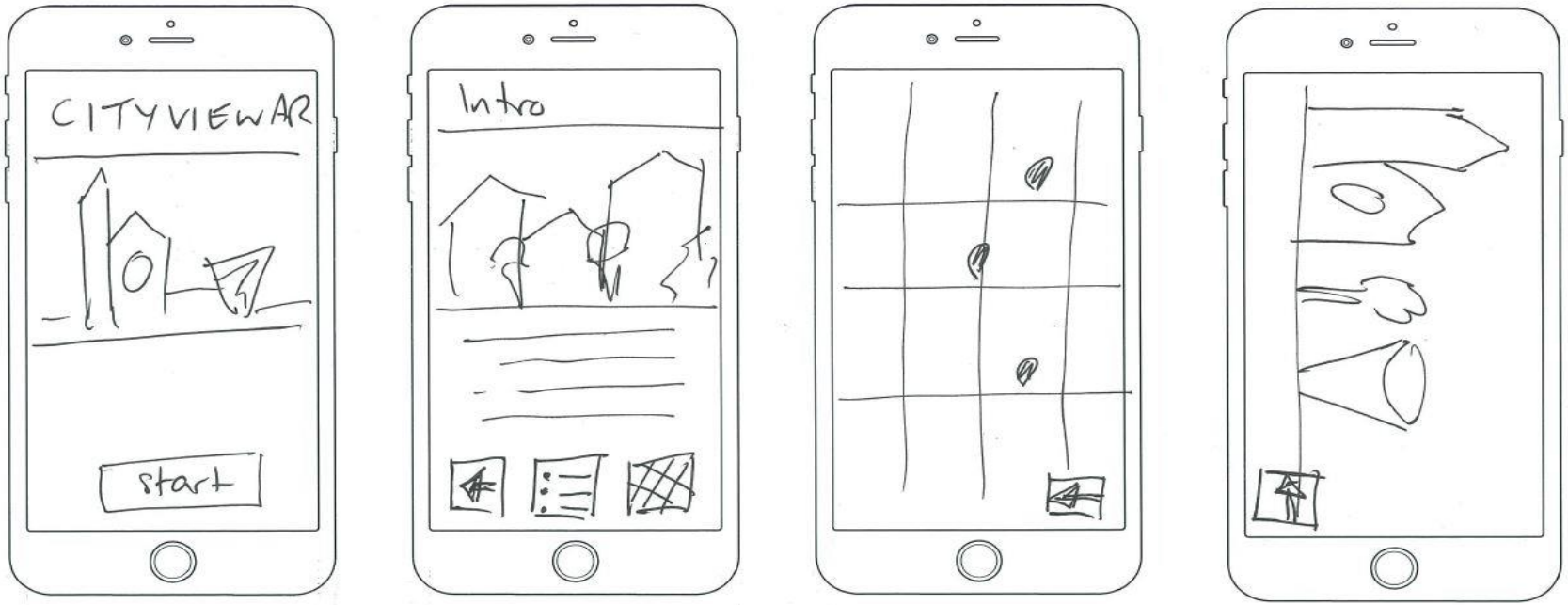
Sketch Interaction Flow/Wireframe



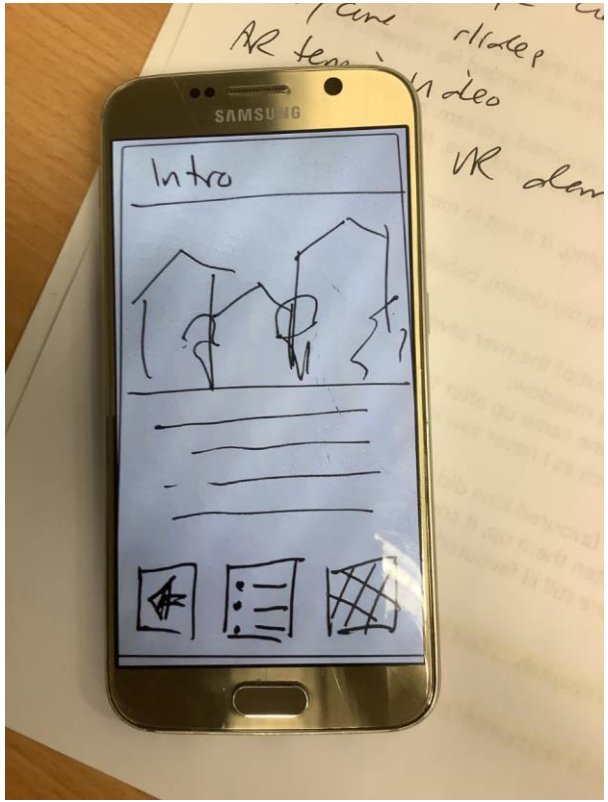
Interaction Flow



Sketch Interface



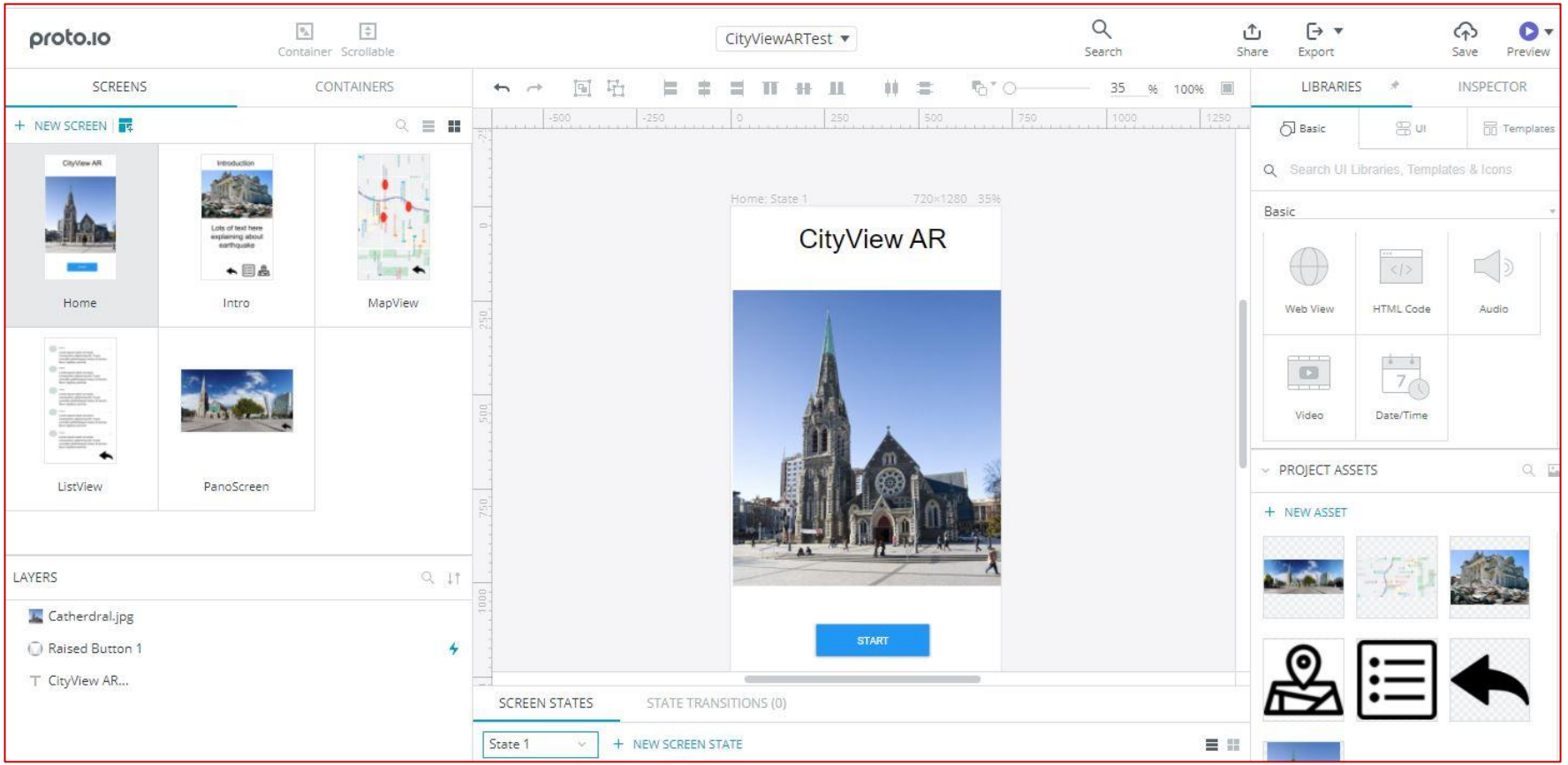
Pop Wireframe



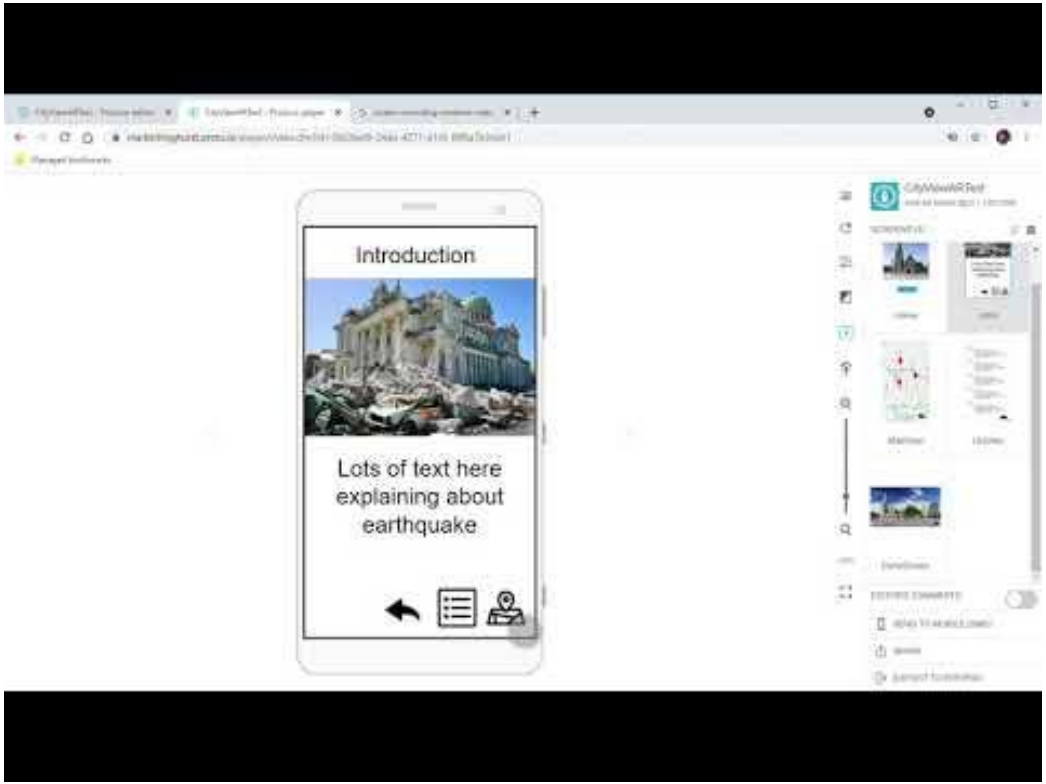
Pop Demo

Asset Collection

High Fidelity - Proto.io

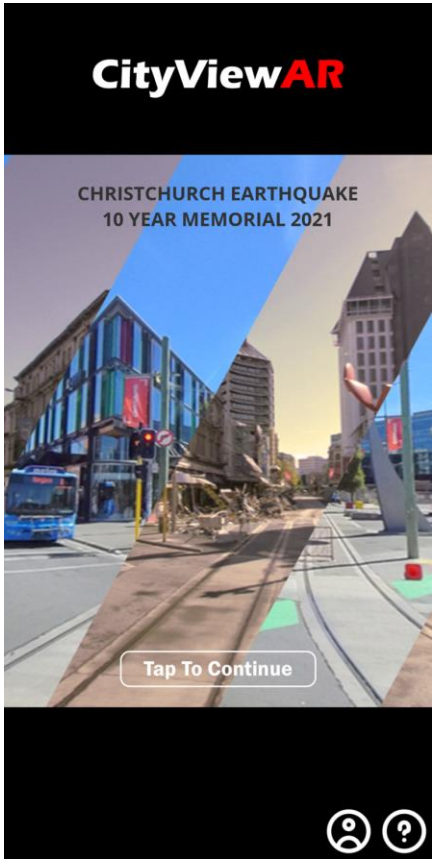


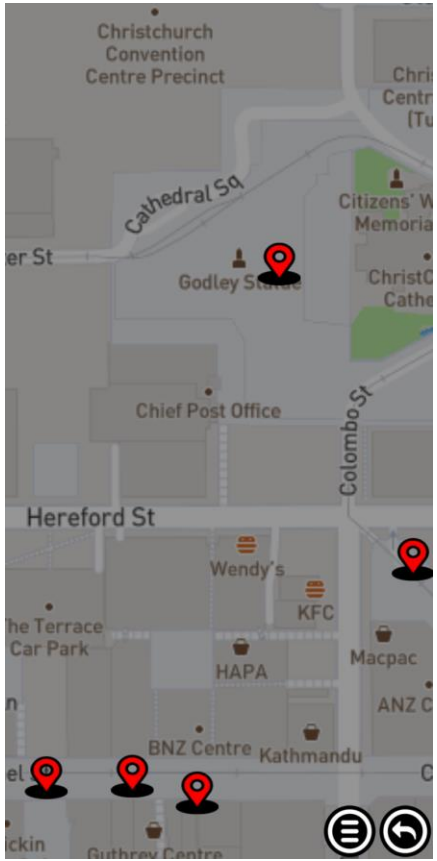
Test Transitions

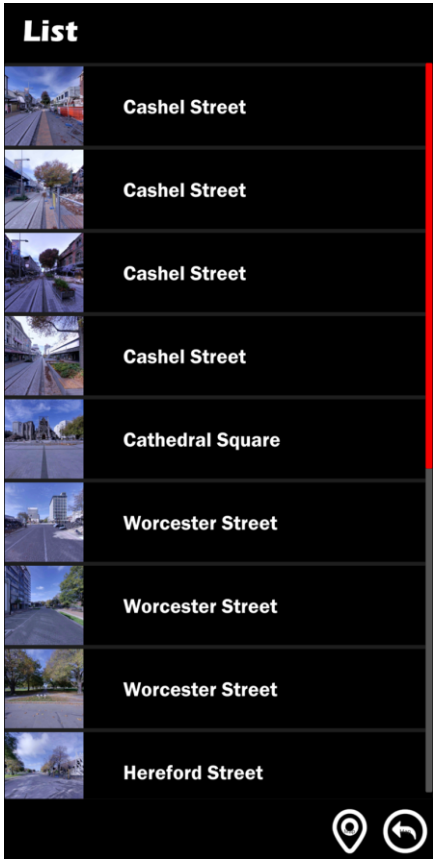


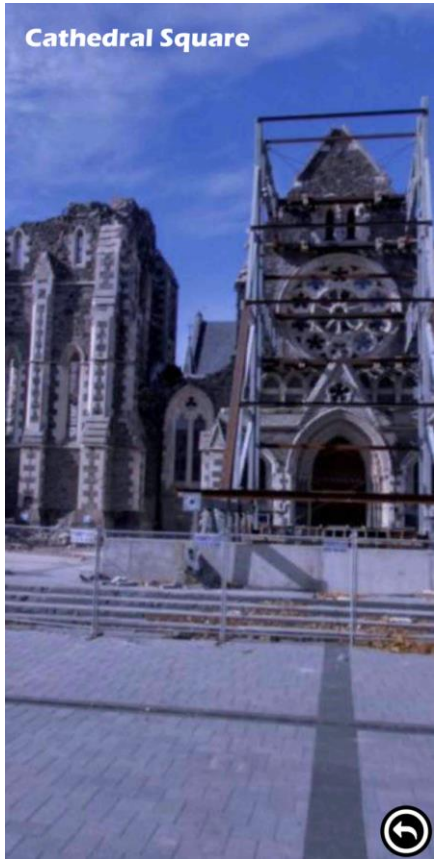
https://youtu.be/eGxgpzXUiMQ

Final Interface Design

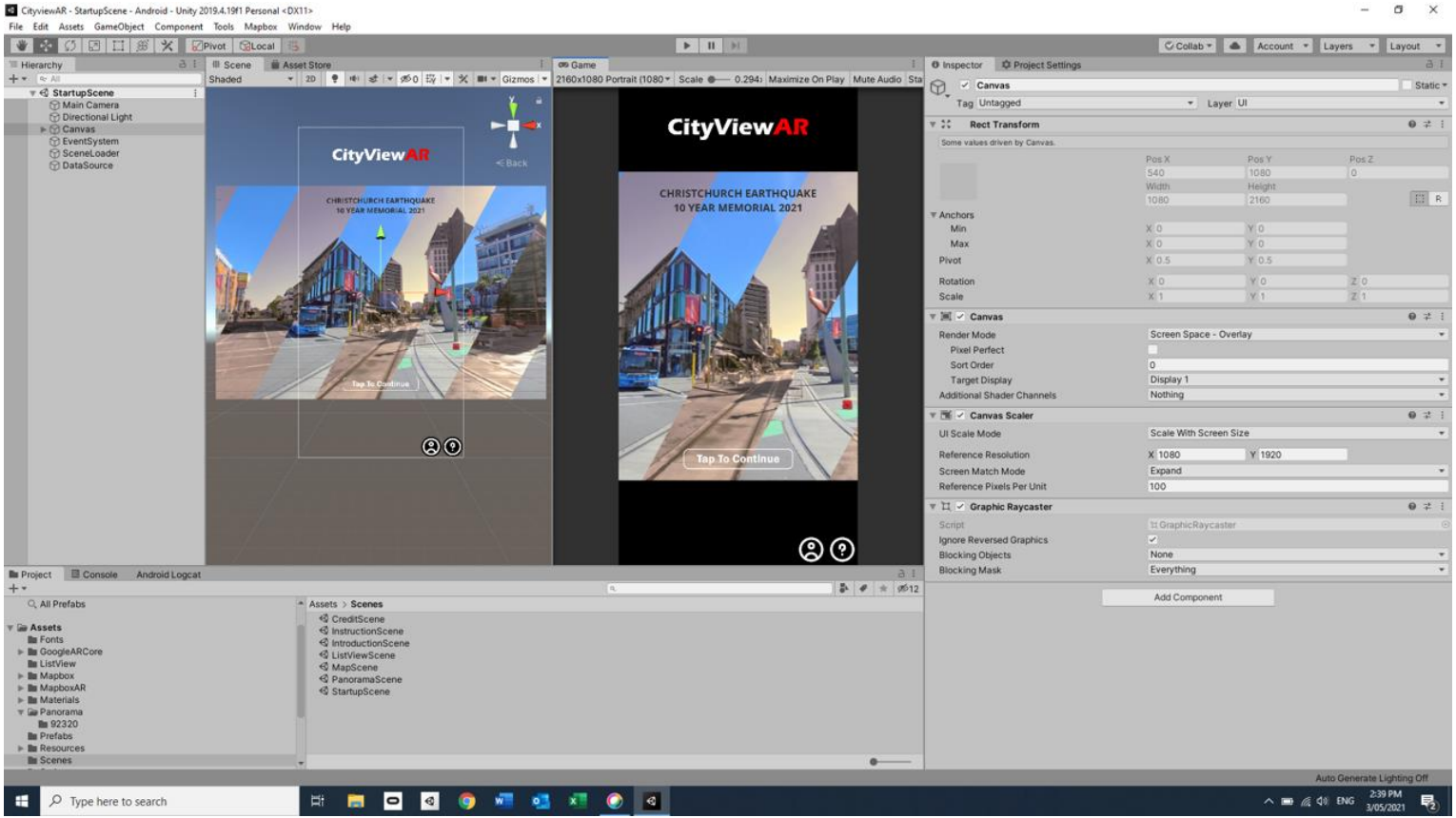




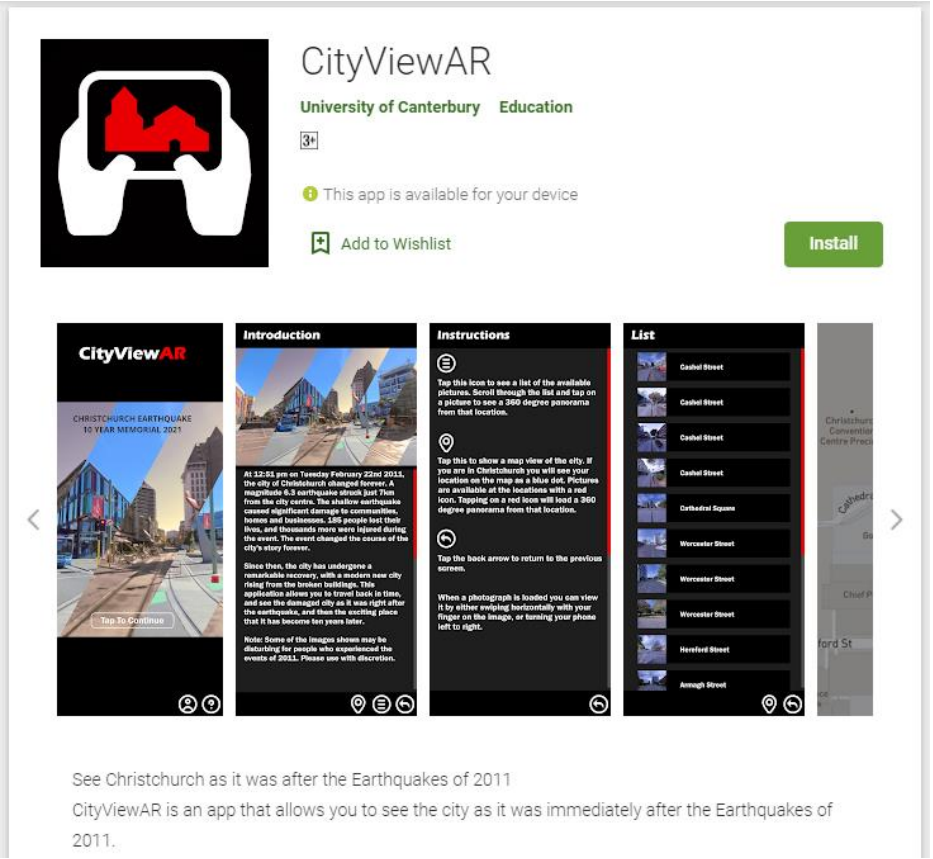




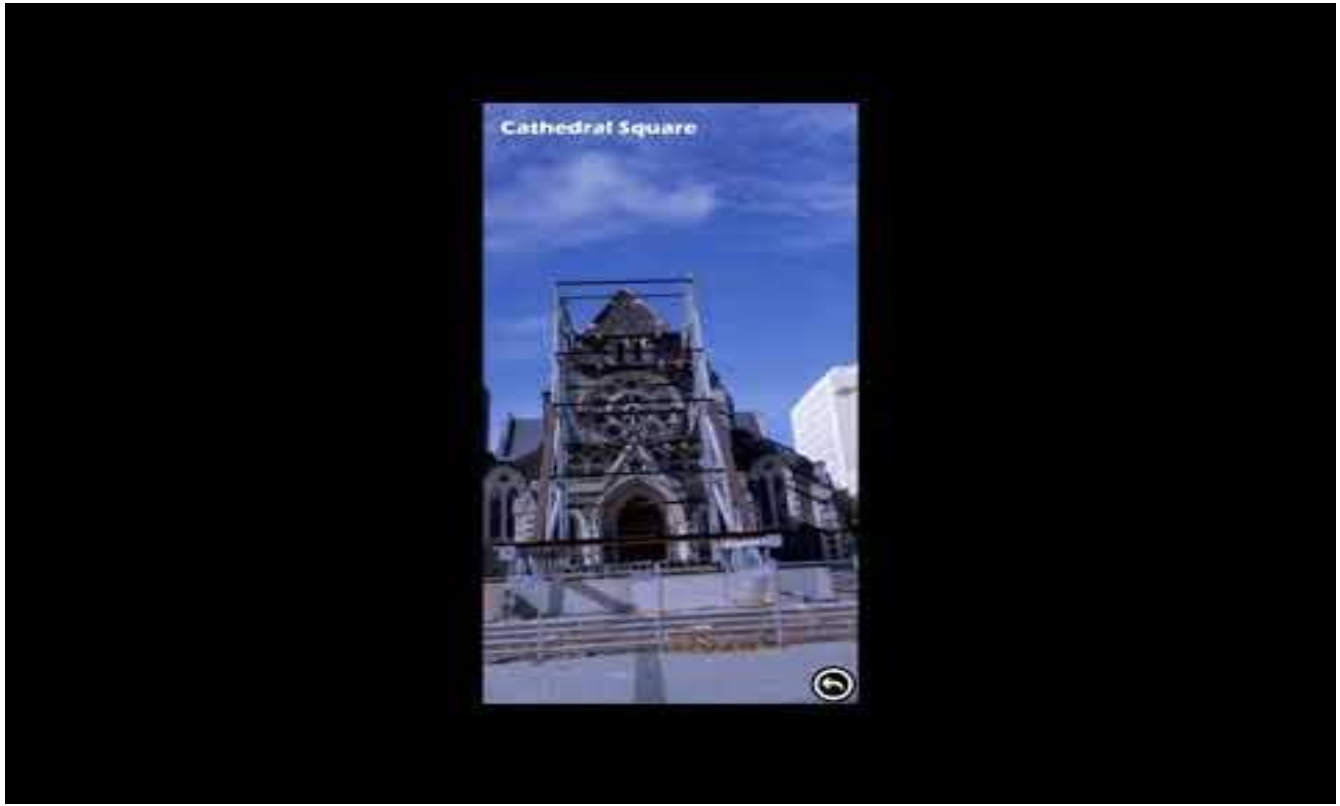
Unity Build


CityViewAR - StartupScene - Android - Unity 2019.4.19f1 Personal <DX11>
File Edit Assets GameObject Component Tools Mapbox Window Help
Hierarchy
StartupScene
Main Camera
Directional Light
Canvas
EventSystem
SceneLoader
DataSource
Scene
Asset Store
Game
CityViewAR
CHRISTCHURCH EARTHQUAKE
10 YEAR MEMORIAL 2021
Tap To Continue
Inspector
Project Settings
Canvas
Rect Transform
Render Mode
Screen Space - Overlay
Canvas Scaler
Scale With Screen Size
Reference Resolution
Graphic Raycaster
Add Component
Project
Console
Android Logcat
Assets
Scenes
CreditScene
InstructionScene
IntroductionScene
ListViewScene
MapScene
PanoramaScene
StartupScene
Type here to search

Deployment to App Store

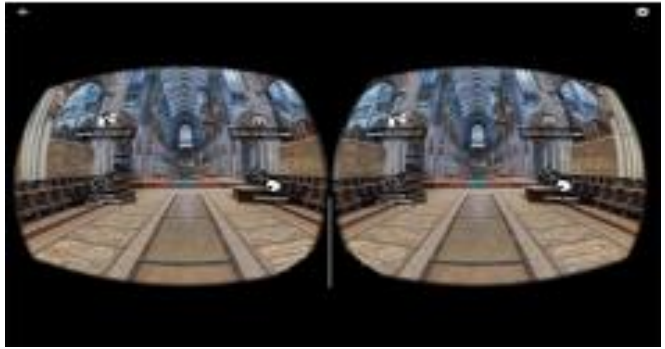


Demo



Interactive 360 Prototyping for VR

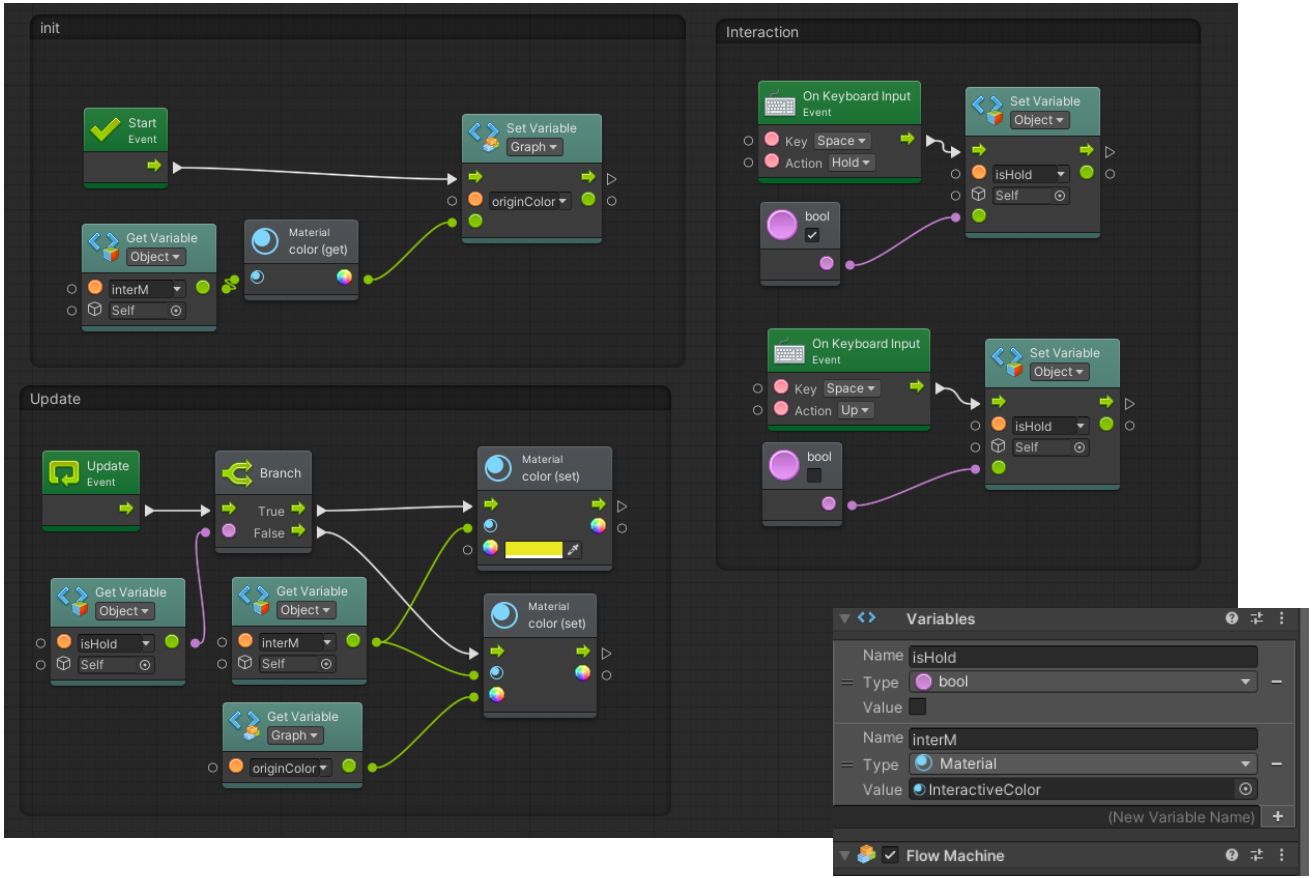
- Create 360 images & interactive elements
- Many possible tools
  - InstaVR
    - http://www.instavr.co/
    - Free, fast panorama VR
    - Drag and drop web interface
    - Deploy to multi platforms (Quest, Vive, phone, etc)
  - VR Direct
    - https://www.vrdirect.com/
    - Connect multiple 360 scenes
    - Instant content update
  - EasyVR
    - https://www.360easyvr.com/



VR Visual Programming

- Drag and drop VR development
  - Visual Programming for Unity
- VR Easy - http://blog.avrworks.com/
  - Key VR functionality (navigation, etc)
  - HMD and VR controller support
- Bolt
  - Rich visual flow
  - Integrated with Unity
- Playmaker - https://hutonggames.com/
  - Popular game authoring tool
  - Can be combined with VR toolkits

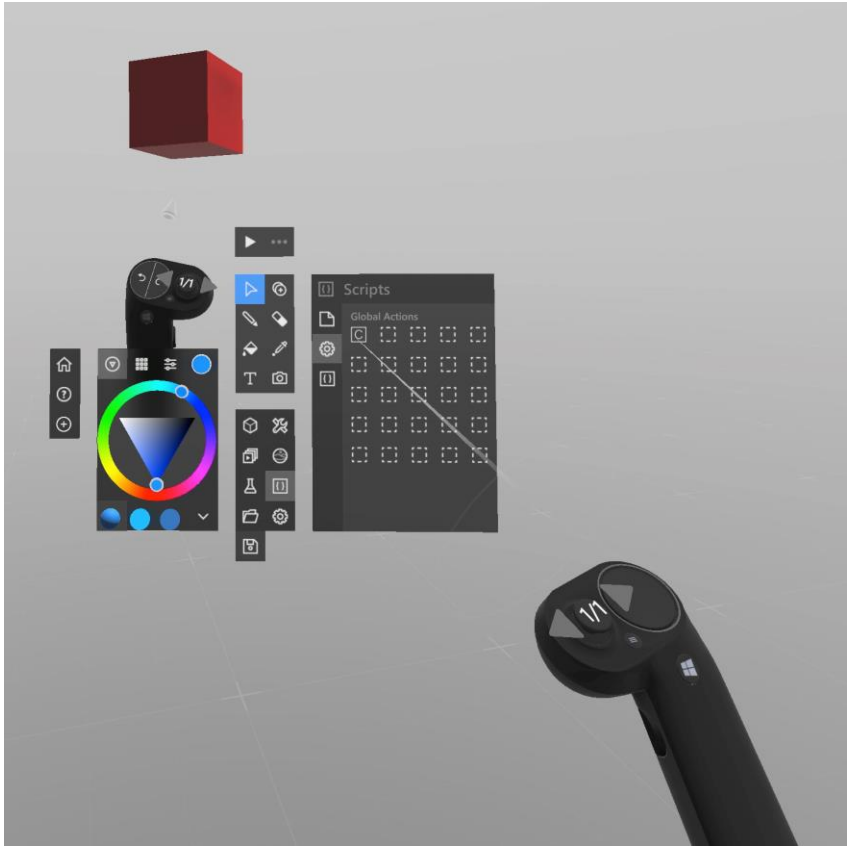
VR Visual Programming with Bolt



VR Immersive Authoring with Maquette

- Maquette integration into Unity
  - Export from Maquette
  - Import into Unity
  - Add scripts/behaviours

VR Visual Scripting in Maquette




```
function PutInFrontOfUser(obj, x, y, r, g, b)
{
  obj.Position = user.PositionInFront(0.6);
  obj.rotation = user.RotationToFace(obj);
  obj.scale = V3(0.1, 0.1, 0.1);
  obj.color = Color(r, g, b);
  obj.translate(V3(x, y, 0.0));
  return obj;
}
```

Example: Attach object to user

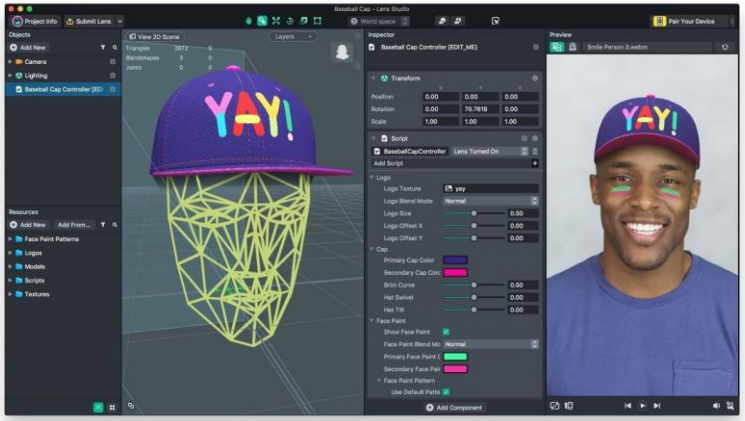
CSCS script coding

Load script in Maquette

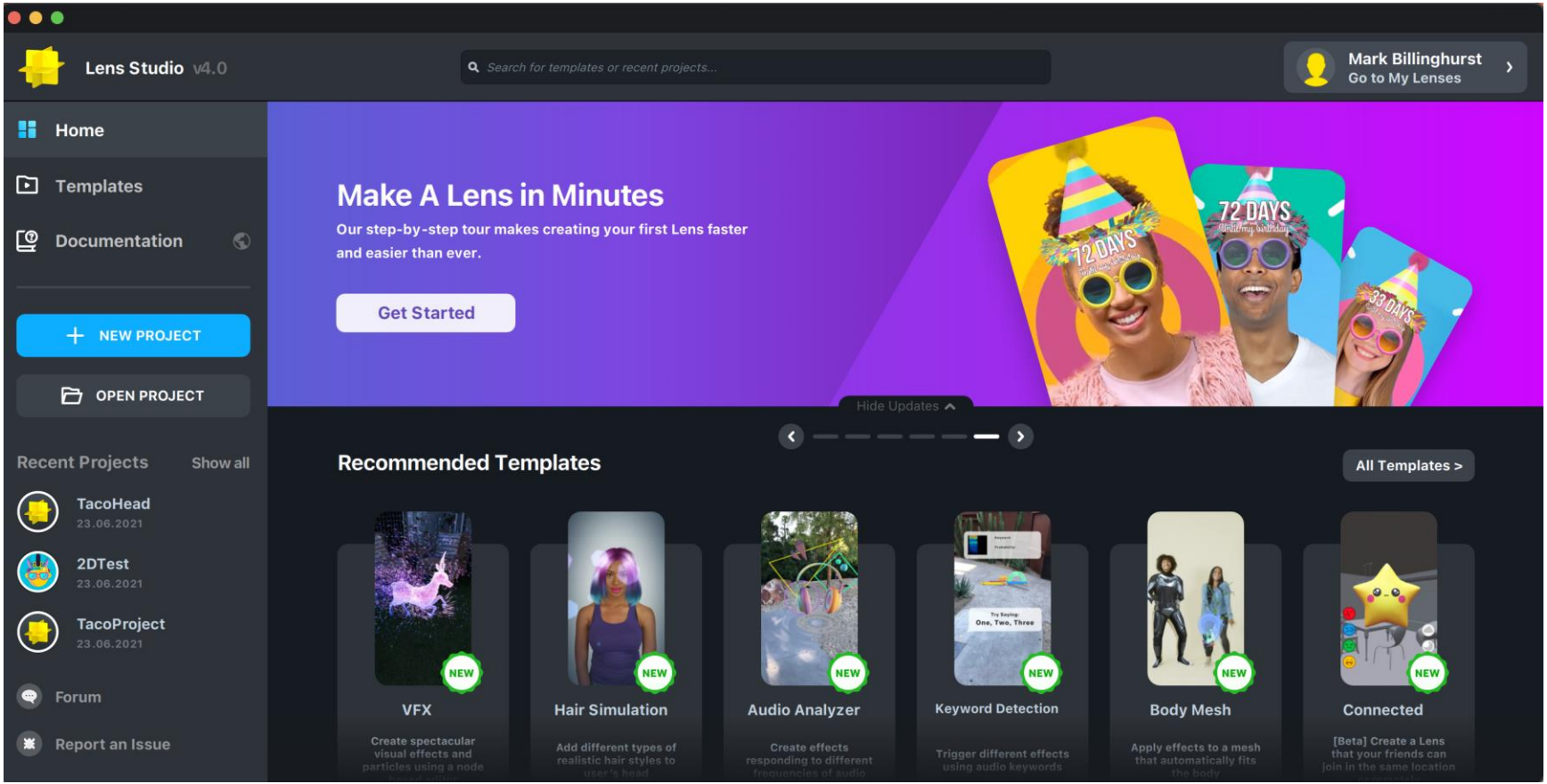
Attach to object

AR Visual Programming

- Rapid prototype on desktop
  - Deliver on mobile
  - Simple interactivity
- Examples
  - Zapworks Studio
    - https://zap.works/studio/
  - Snap Lens Studio
    - https://lensstudio.snapchat.com/
  - Facebook Spark AR Studio
    - https://sparkar.facebook.com/ar-studio/



Lens Studio


Lens Studio v4.0
Search for templates or recent projects...
Mark Billinghurst
Go to My Lenses
Home
Templates
Documentation
NEW PROJECT
OPEN PROJECT
Recent Projects
Show all
TacoHead
23.06.2021
2DTest
23.06.2021
TacoProject
23.06.2021
Forum
Report an Issue
Make A Lens in Minutes
Our step-by-step tour makes creating your first Lens faster and easier than ever.
Get Started
72 DAYS
33 DAYS
Hide Updates
Recommended Templates
All Templates >
NEW
VFX
Create spectacular visual effects and particles using a node
Hair Simulation
Add different types of realistic hair styles to
Audio Analyzer
Create effects responding to different
Keyword Detection
Try Saying:
One, Two, Three
Trigger different effects using audio keywords
Body Mesh
Apply effects to a mesh that automatically fits
Connected
[Beta] Create a Lens that your friends can join in the same location

AR Visual Programming with Lens Studio

Author and preview AR prototypes

- Tool behind Snapchat Lenses, but also a powerful AR prototyping tool
- Can do face (using front camera) and world lenses (rear camera)
- Simulated previews using webcam

Deploy and use advanced AR features

- Can deploy to phone running Snapchat app via Snapcode
- Has advanced AR tracking and segmentation capabilities

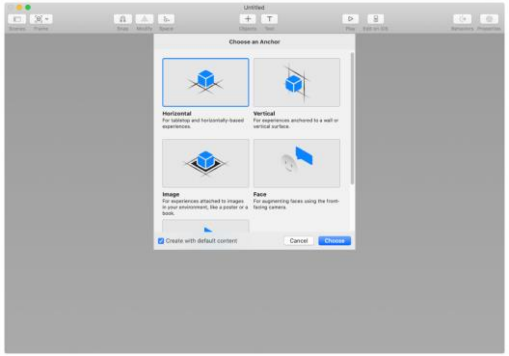
Some specific features

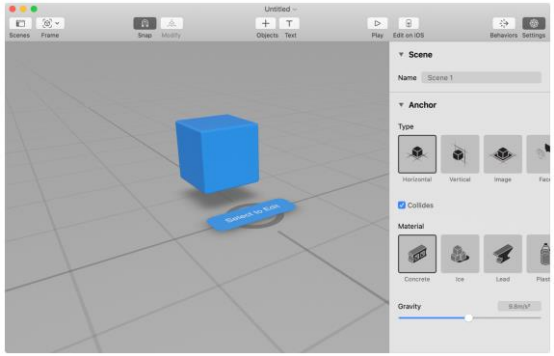
- SnapML: train and use ML models
- Face landmarks: track 93 points
- Face expressions: detect winks etc.
- Eye tracking: get eye pos/rotation
- Behavior: set triggers & actions
- UI: add UI widgets without scripting
- Visual scripting: no code via graphs
- Templates: lots of templates and tutorials (we'll explore later)

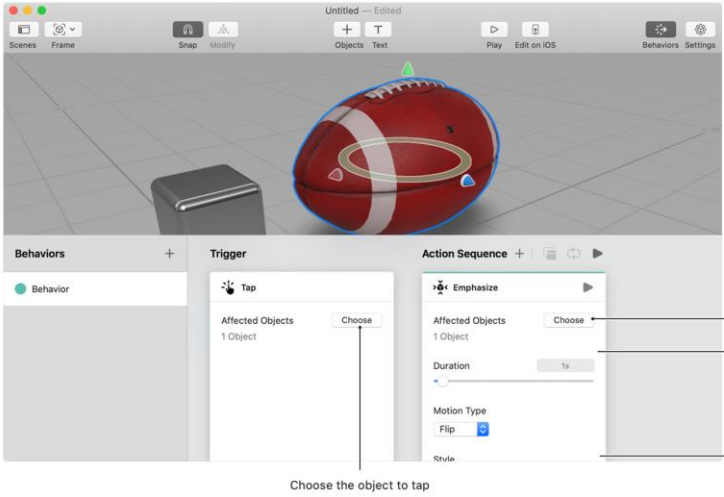
AR Immersive Authoring with Aero

- Adobe Aero
  - Create AR on mobile devices
  - Touch based interaction and authoring
  - Only iOS support for now
- https://www.adobe.com/nz/products/aero.html

Apple Reality Composer







- Rapidly create 3D scenes and AR experiences
  - Creation on device (iPhone, iPad)
  - Drag and drop interface
  - Loading 2D/3D content
  - Adding simple interactivity
- Anchor content in real world (AR view)
  - Planes (vertical, horizontal), faces, images

Hand-held vs. Head-worn AR

Varying display sizes	**Usually small display (FOV)**
Mix of 2D/3D content + touch • 2D screen + touch • 3D world + touch • Device motion gestures • Voice commands	**HUD + 3D content + gesture** • HUD + hand/voice • 3D world + hand gestures • Head/eye gaze • Voice commands
Marker-based *or* marker-less • Marker-based tracking • Marker-less tracking • Extended tracking	***Advanced* tracking with** • Inside-out 6DOF tracking • Spatial mapping • Scene understanding

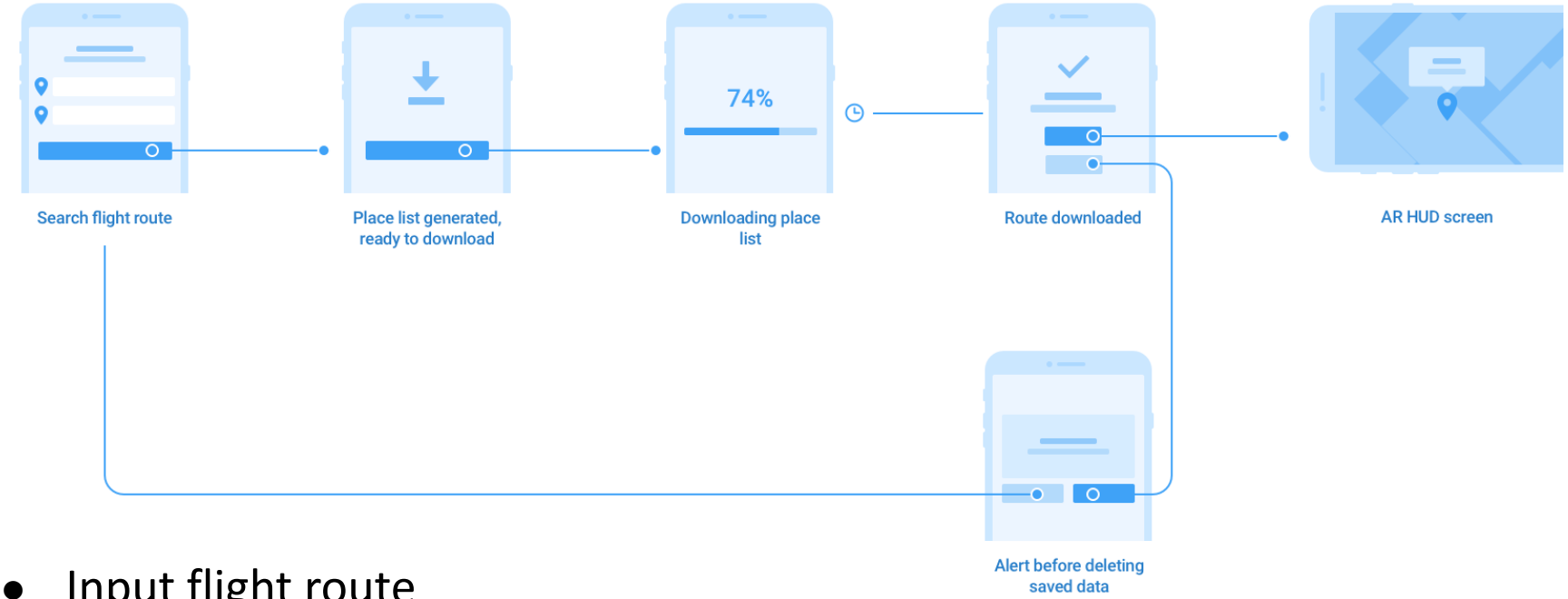
Case Study: Interactive Flight AR App

https://blog.prototypr.io/making-flights-more-interesting-with-augmented-reality-322eecde827c

Flight Augmented Reality Application

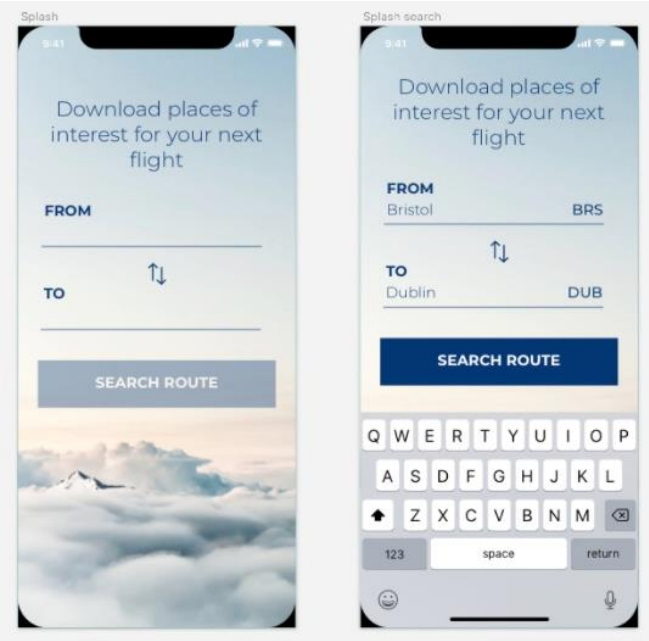
- Hold up mobile phone to see POI out of plane window
- AR tags in real world
- Tap tags for more information

Interaction Flow



- Input flight route
- View AR HUD

Design Interface Screens



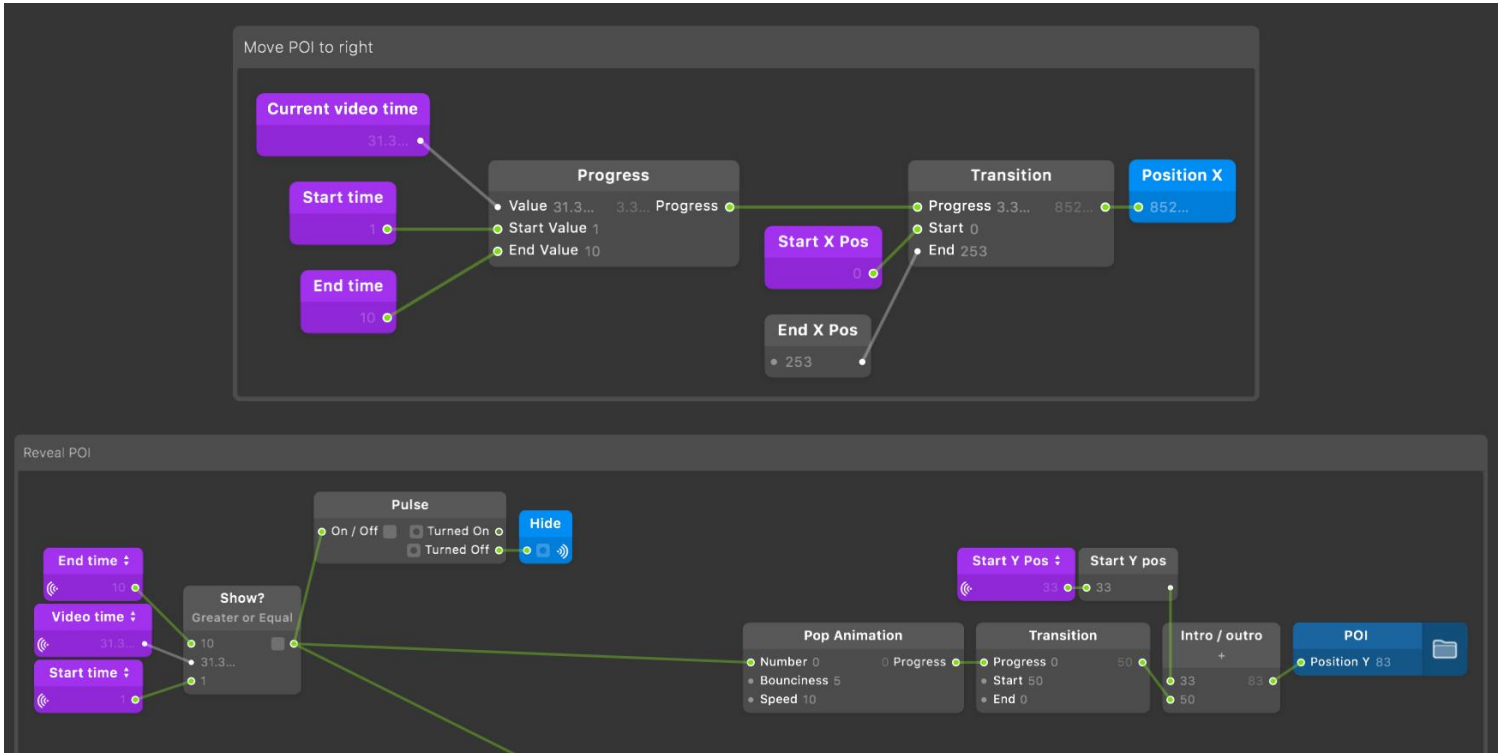
- Using Sketch - https://www.sketch.com/

Create AR View

- Use looped video
- Load into Origami Studio
- Add POI onto video
- Animate POI with video
- Add touch interactions to POI

https://www.youtube.com/watch?v=ejzS0atCtgQ

Add POI and Move with Video

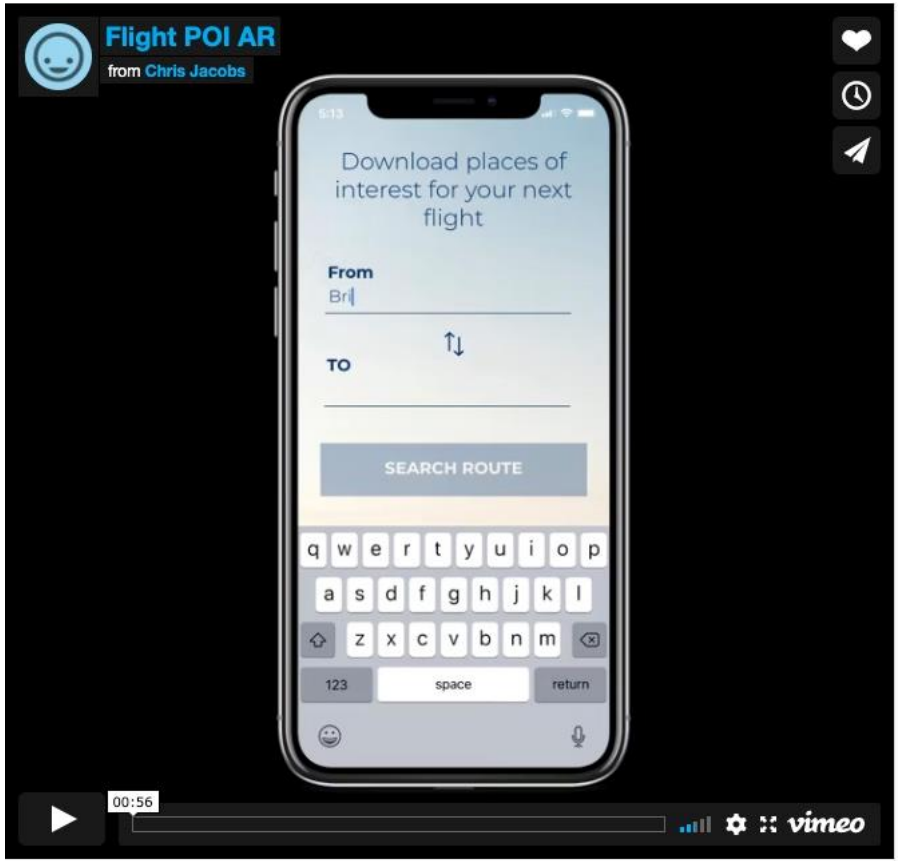


- Use Origami Studio - https://origami.design/

Add Touch Interaction

- Add information toggling based on touch input (Origami Studio)

Final Demo Video



https://vimeo.com/254711113

XR Development with WebXR, Unity, Unreal

XR Process

1.

Needfinding & Brainstorming

Framing the problem via scenarios & use cases, personas, and competitors

2.

Storyboarding & Prototyping

Creating mockups using paper and digital tools, involving XR devices

3.

Development & Testing

Creating application using WebXR, Unity/Unreal, or native SDK

4.

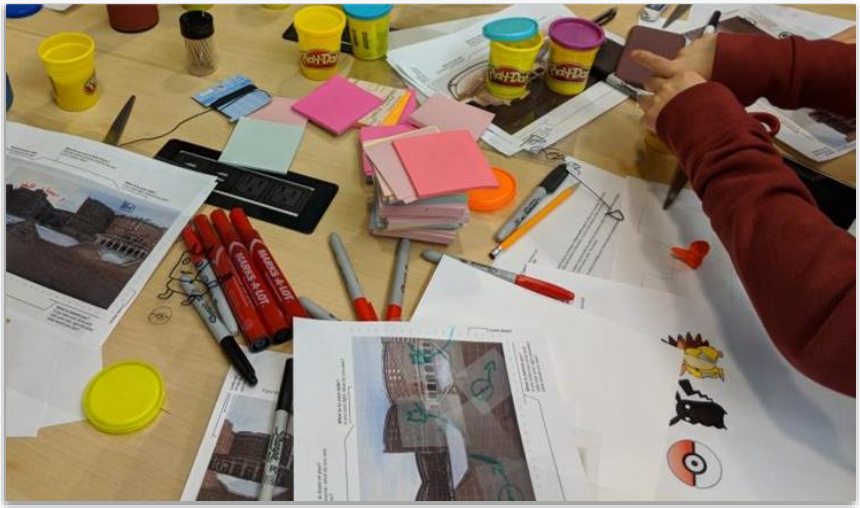
Deployment & Analytics

Deploying application on XR device, collecting data during usage

Things You Should Do First

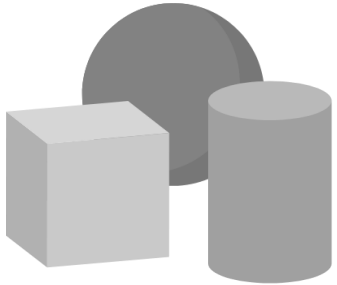
- **Project plan** (define approach & milestones, roles)
- **High-level sketches** (storyboards to shape initial ideas)
- **Detailed sketches** (wireframes to flesh out ideas)
- **Personas** (make it clear who you're designing for & who not)
- **Story maps** (identify goals & tasks)
- **Physical prototypes** (explore interactions without limits)
- **Digital prototypes** (test interactions for feasibility)

Importance of Physical & Digital Prototypes

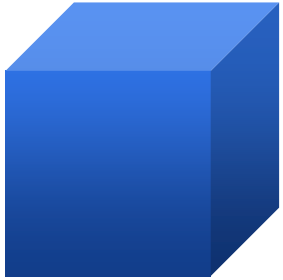


- Quick & dirty
- Explore interactions
- Get initial user feedback
- Avoid premature commitment
- Devise technical requirements

Content and Interaction



Placeholder Content

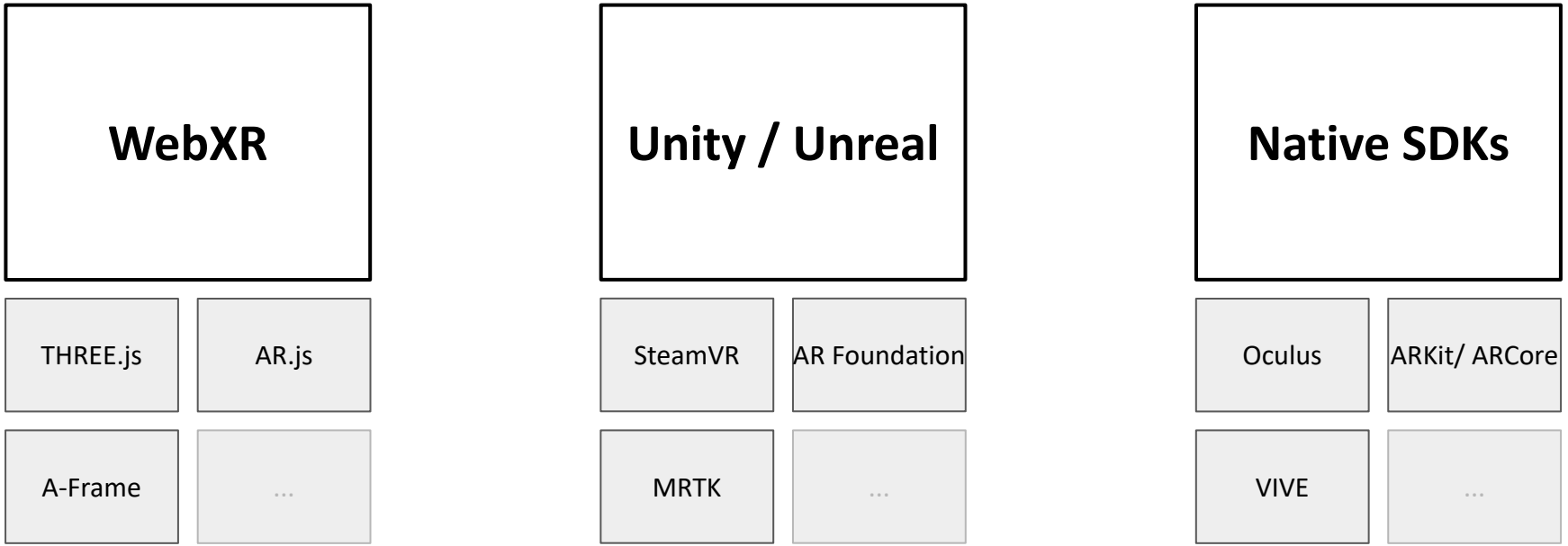


Polished Content

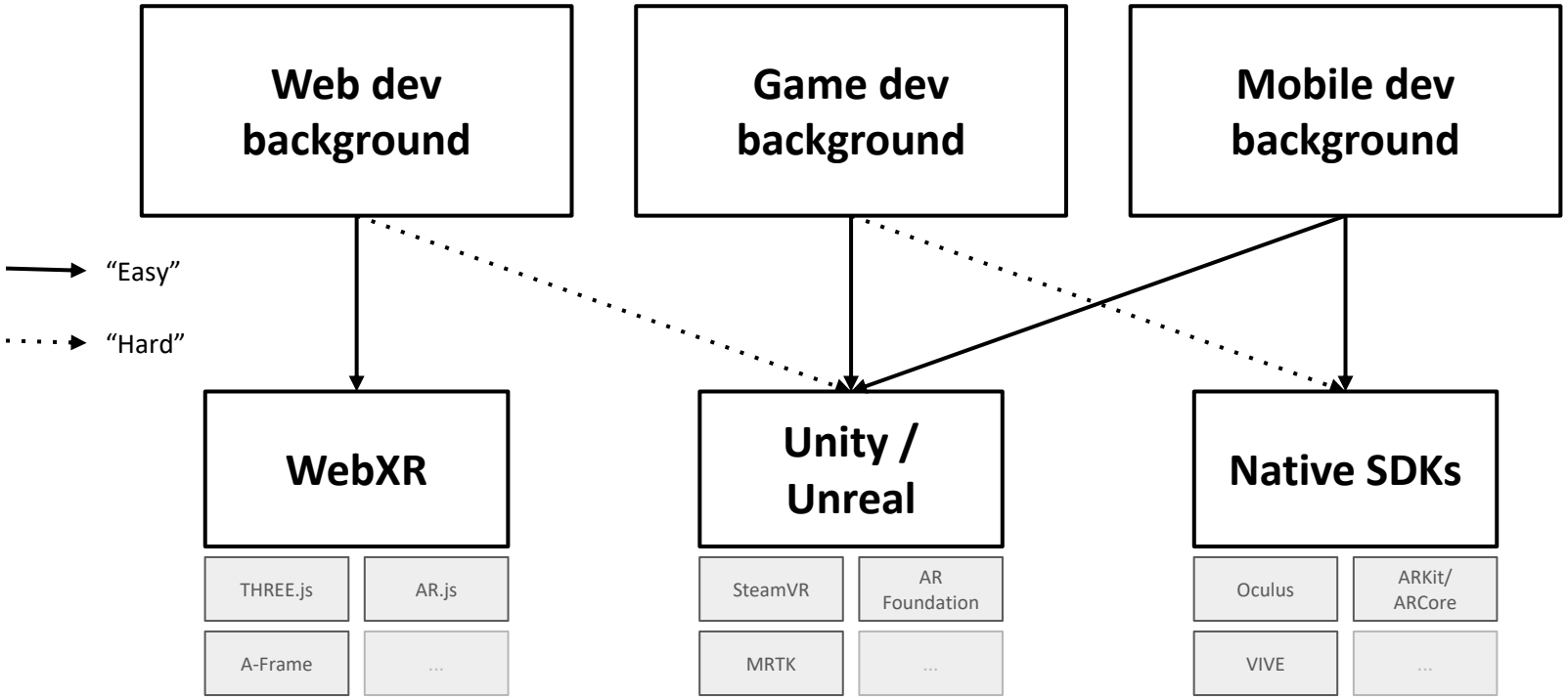
Implicit & Explicit Interactions

Lo-Fi ---------- *Hi-Fi*

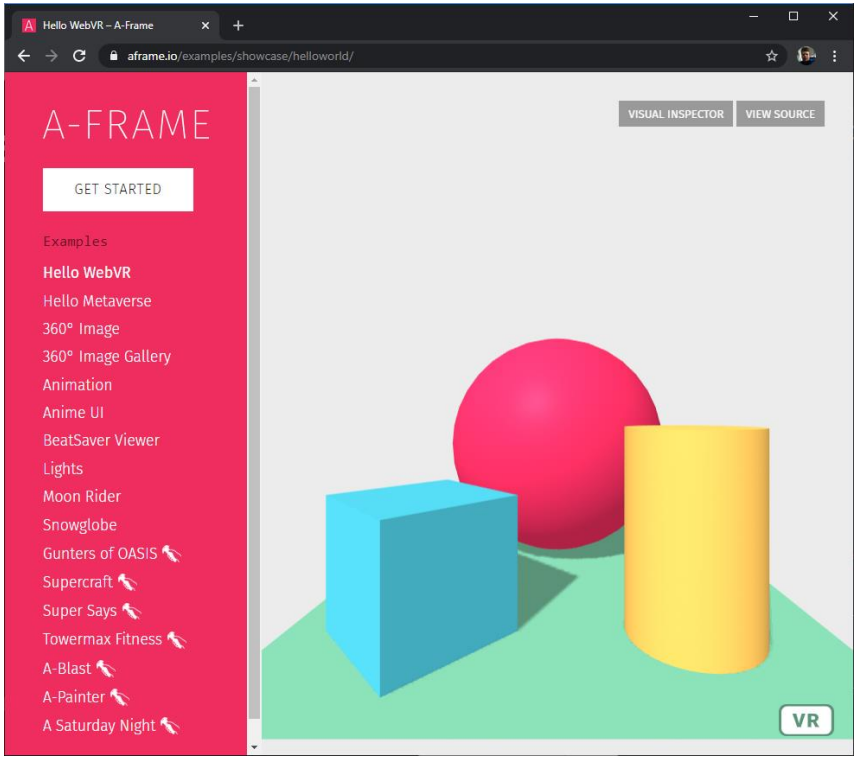
Development and Testing



Paths to Being an XR Developer

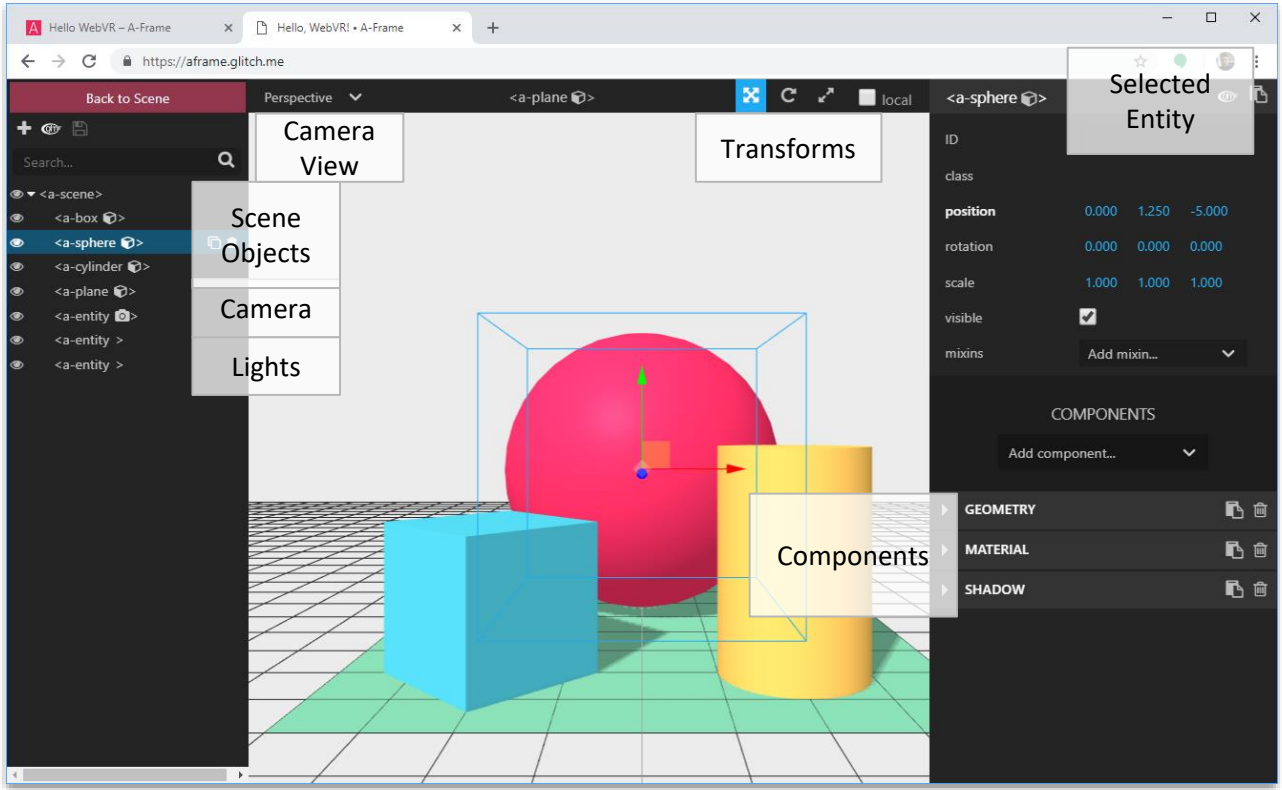


A-Frame

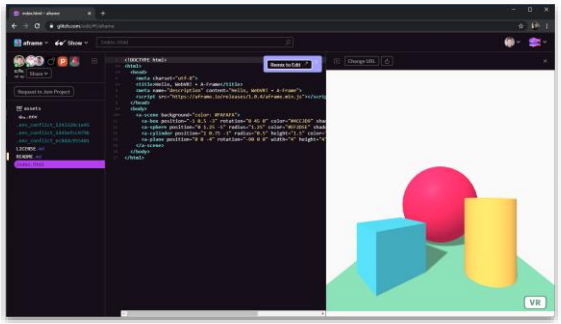


- Based on Three.js and WebGL
- New HTML tags for 3D scenes
- A-Frame Inspector (not editor)
- Asset management (img, video, audio, & 3D models)
- ECS architecture with many open-source components
- Cross-platform XR

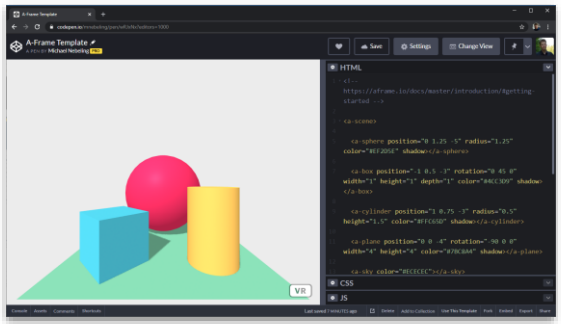
A-Frame Inspector



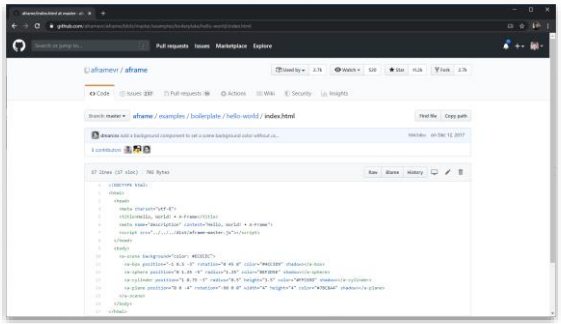
A-Frame Development Environments



Glitch



CodePen

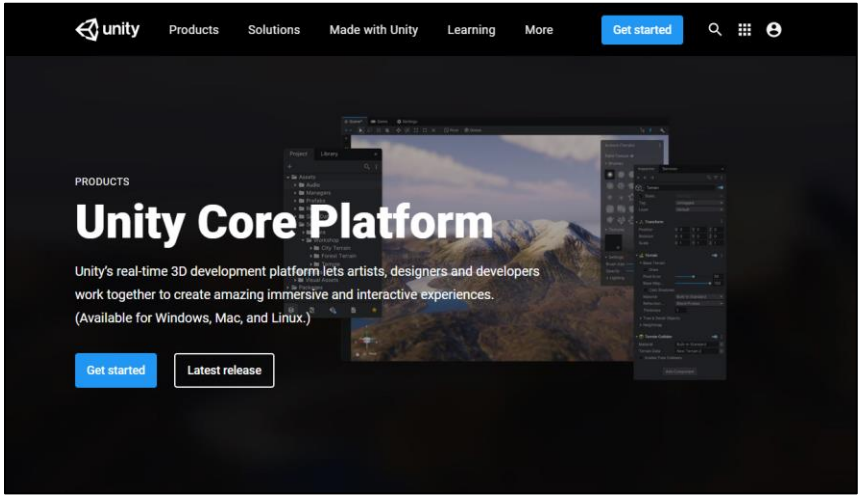


GitHub (custom)

A-Frame and VR

A-Frame and AR

Unity



- Started out as game engine
- Has integrated support for many types of XR apps
- Powerful scene editor
- Asset management & store
- Basically all XR device vendors provide Unity SDKs

Unity and VR

XR Plugin

Unity 2019.3 or higher

XR Interaction Toolkit

Unity 2019.3 or higher

SteamVR

Mixed Reality Toolkit (MRTK)

SteamVR or Oculus

Virtual Reality Toolkit (VRTK)

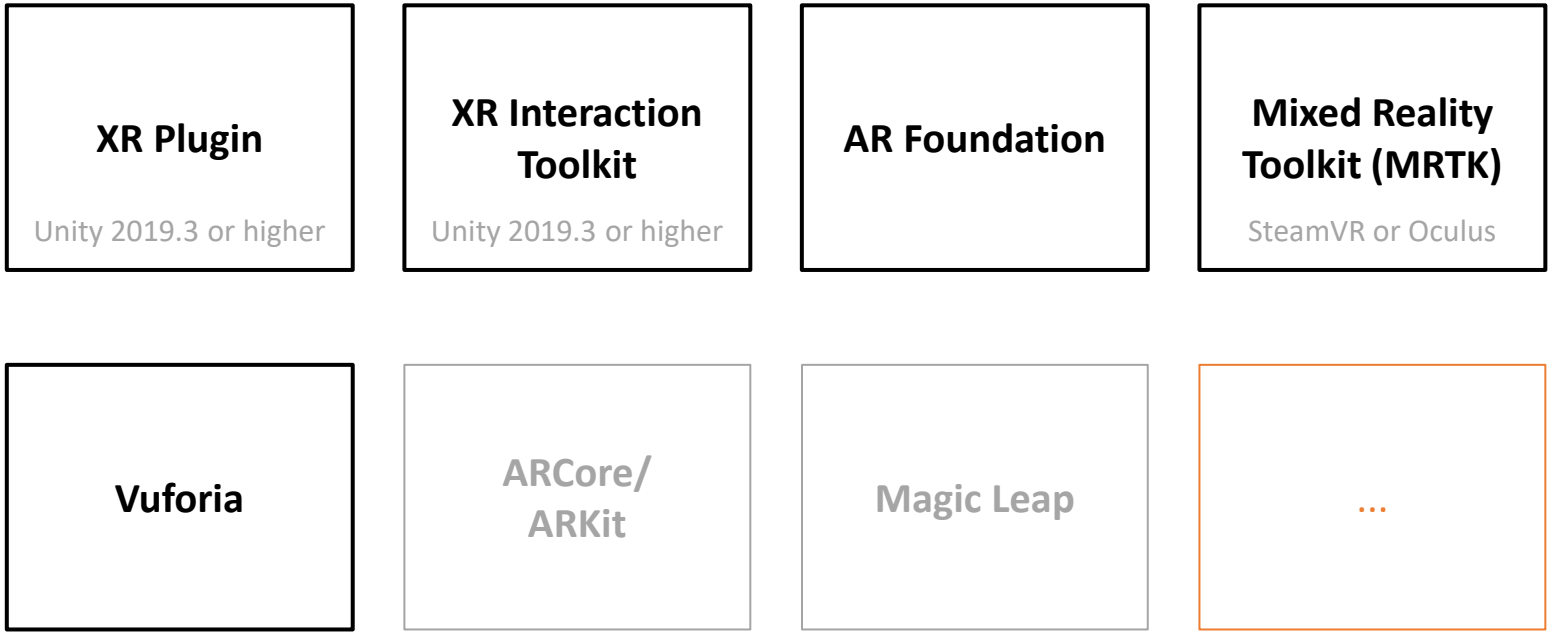
SteamVR or Oculus

Oculus/ VIVE

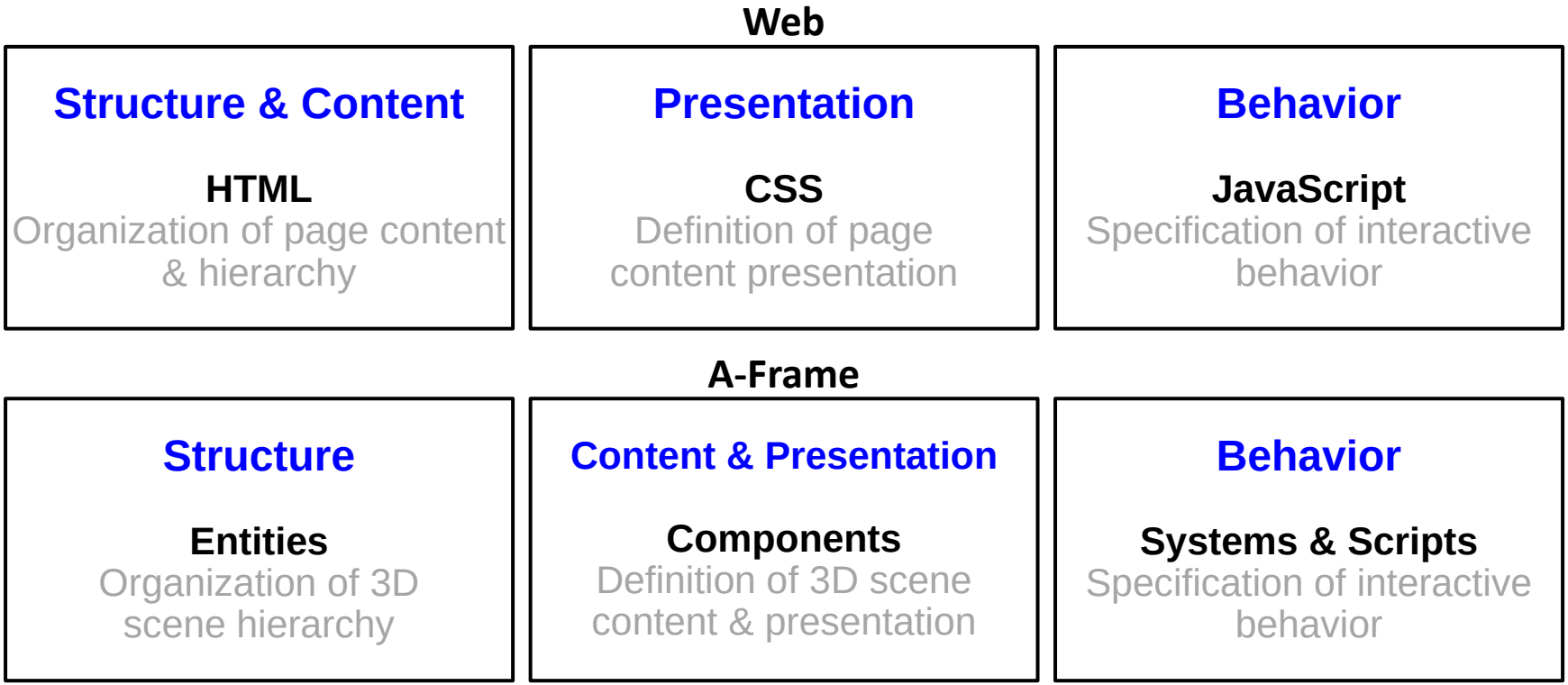
Cardboard/ Daydream

...

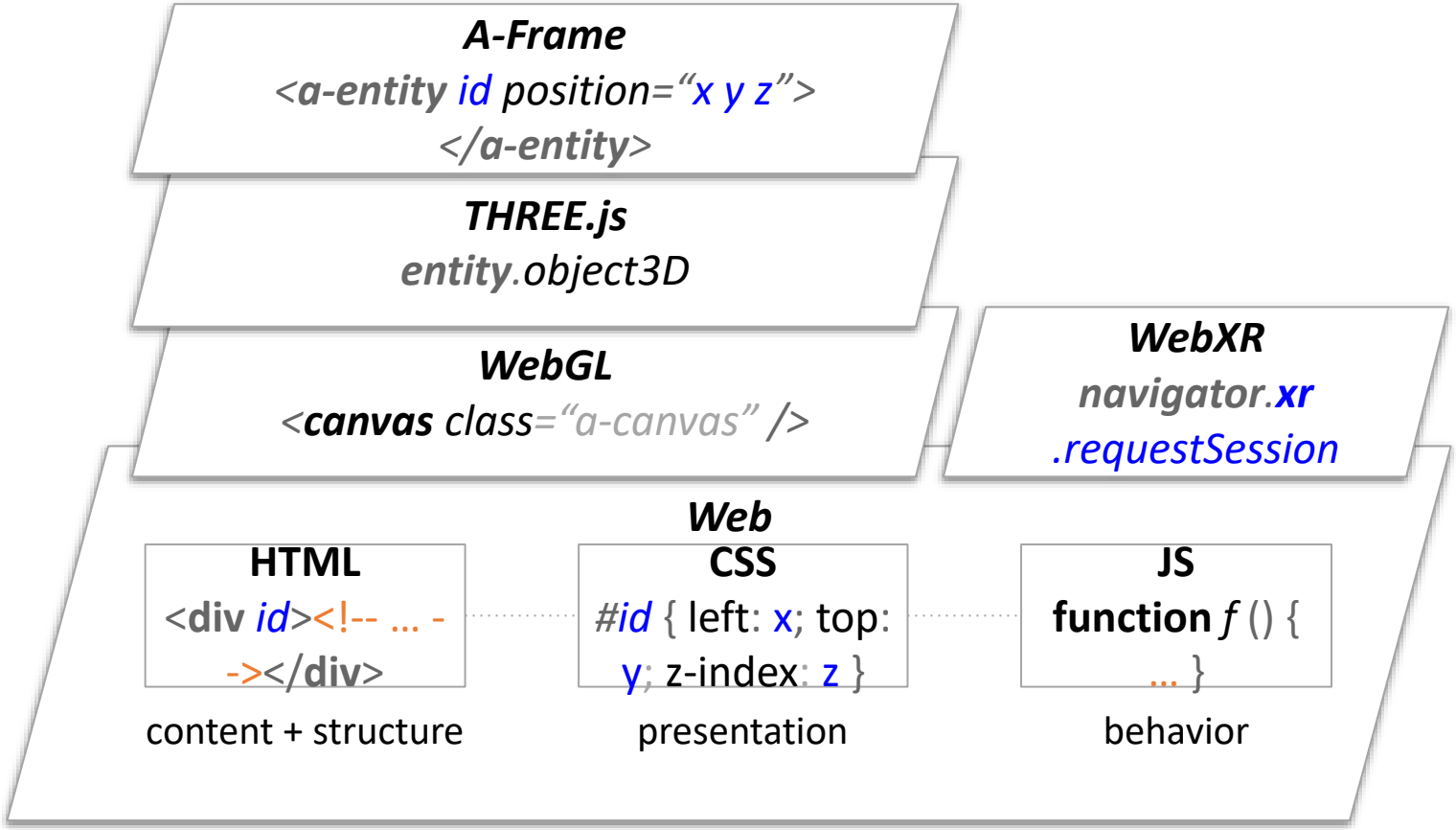
Unity and AR


XR Plugin
Unity 2019.3 or higher
XR Interaction Toolkit
Unity 2019.3 or higher
AR Foundation
Mixed Reality Toolkit (MRTK)
SteamVR or Oculus
Vuforia
ARCore/ ARKit
Magic Leap
...

Web vs. A-Frame



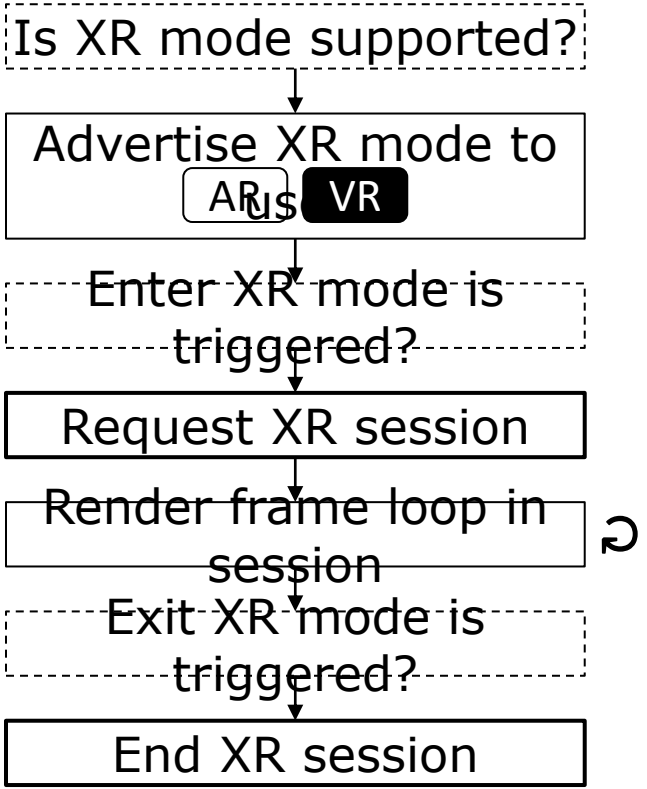
WebXR and A-Frame



WebXR

Enable XR applications on the web by allowing pages to:

- **Detect** XR capabilities
- **Query** XR device capabilities
- **Poll** XR device and associated input device state
- **Display** imagery on XR device at the appropriate frame rate



Unity vs. A-Frame

Unity is a game engine and XR dev platform

- De facto standard for XR apps
- Increasingly built-in support
- Most “XR people” will ask you about your Unity skills :-)

Support for *all* XR devices

- Basically all AR and VR device vendors provide Unity SDKs

A-Frame is a declarative WebXR framework

- Emerging XR app development framework on top of THREE.js
- Good for novice XR designers with web dev background

Support for *most* XR devices

- Full WebXR support in Firefox, Chrome, & Oculus Browser

Unity vs. Unreal

1. What level of visuals are you after?

Unreal offers high-quality visuals straight out of the box. Unity won't produce quite the same quality.

2. Are you a developer or a designer?

Developers often prefer Unity; designers/3D artists opt for Unreal.

3. What is your development environment?

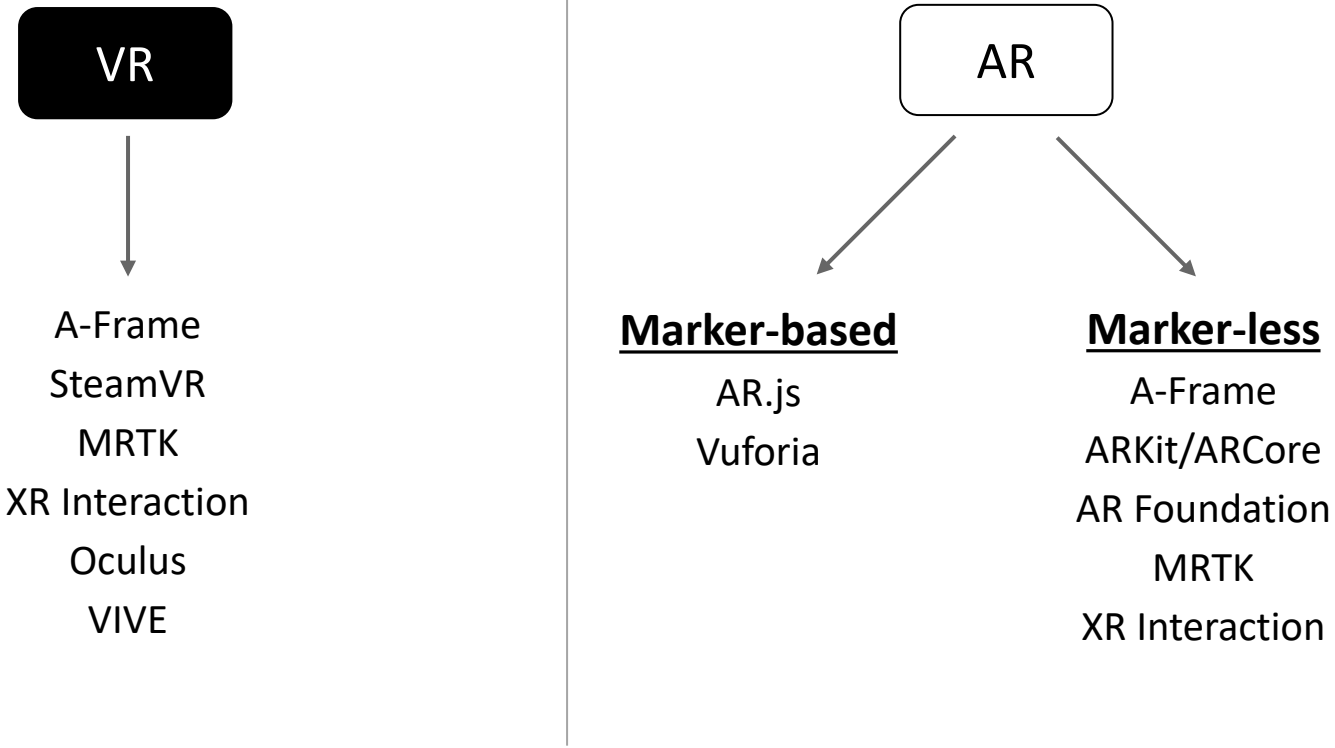
Unity enables you to create complex projects for low-end devices. Unreal requires a powerful PC and broadband internet setup.

4. What device is your project aimed at?

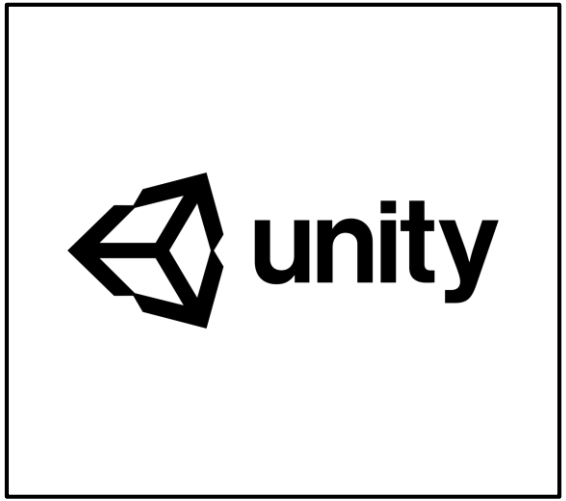
Unreal supports XR but there is some overhead. Unity has native XR.

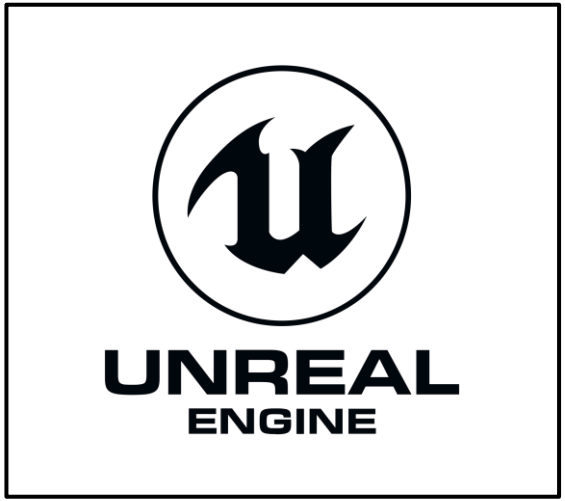
XR Platforms and Toolkits

XR Platforms and Toolkits



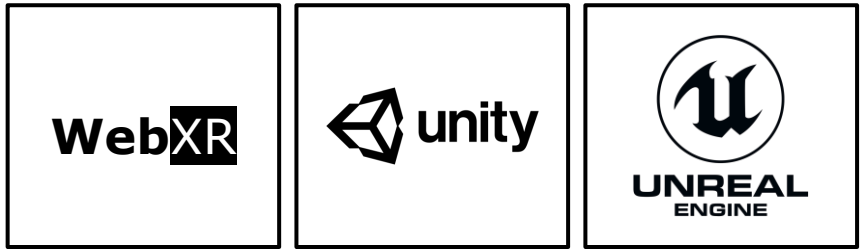
XR Platforms

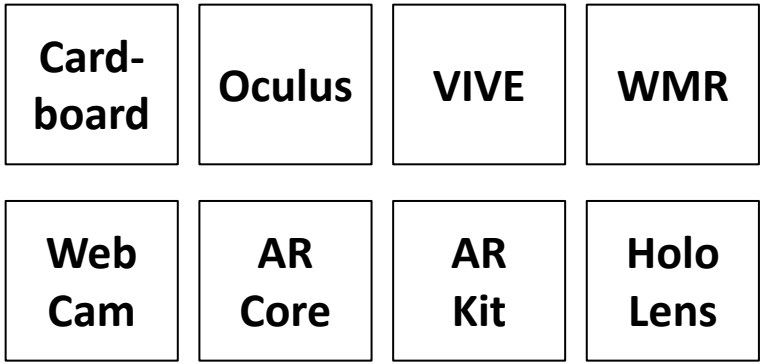




XR Toolkits

A-Frame
AR.js
SteamVR
MRTK
Vuforia
AR Foundation
XR Interaction





Summary

Building Your VR Toolbox

1) From 2D to 3D

3D objects & transforms

Working with 3D models

3D interactions

2) Designing for VR

Environmental design

Lights & shadows, animations

Spatial sound

3) Basic VR Interactions

Travel

Object selection

Gaze, gesture, & speech input

4) Advanced VR Interactions

Menu design

Object manipulation

Physics & particle systems

Building Your AR Toolbox

1) From VR to AR*

Types of AR displays

Registration, tracking & calibration

Mapping physical to virtual objects

2) Designing for AR

Motion tracking

Environmental understanding

Light estimation

3) Marker-based AR

Marker-based design

Marker-based interactions

From marker-based to marker-less

4) Marker-less AR

Marker-less design

Marker-less interactions

From hand-held to head-worn

* requires that you have built your VR toolbox

Design Guidelines

Design Guidelines

By Vendors

Platform driven

By Designers

User oriented

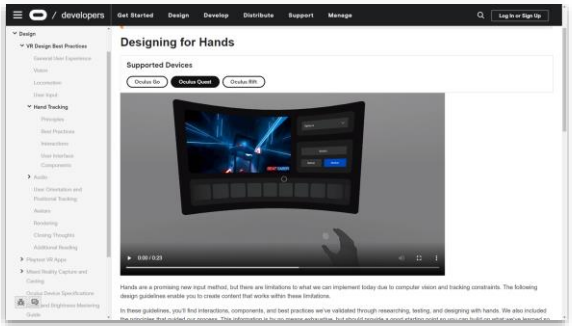
By Practitioners

Experience based

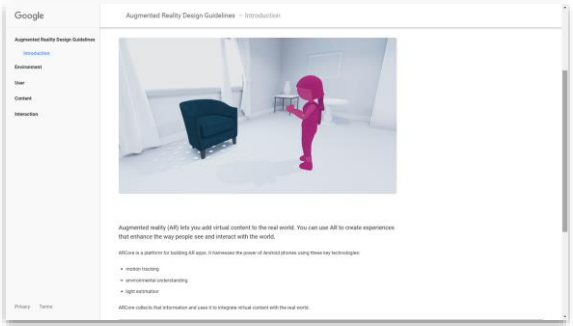
By Researchers

Empirically derived

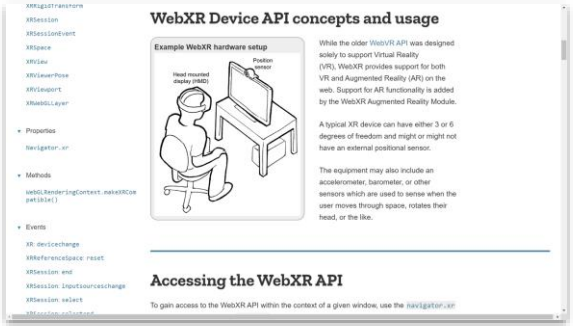
Design Guidelines



Oculus (Go/Quest/Rift)



Google (ARCore)



Mozilla (WebXR)

The Trouble with XR Design Guidelines

1) **Rapidly evolving best practices**
   - Still a moving target, lots to learn about XR design
   - Slowly emerging design patterns, but often change with OS updates
   - Already major differences between device platforms
2) **Challenges with scoping guidelines**
   - Often too high level, like “keep the user safe and comfortable”
   - Or, too application/device/vendor-specific
3) **Best guidelines come from learning by doing**
   - Test your designs early and often, learn from your own “mistakes”
   - Mind differences between VR and AR, but less so between devices

The Do’s and Don'ts of XR Design

Do’s

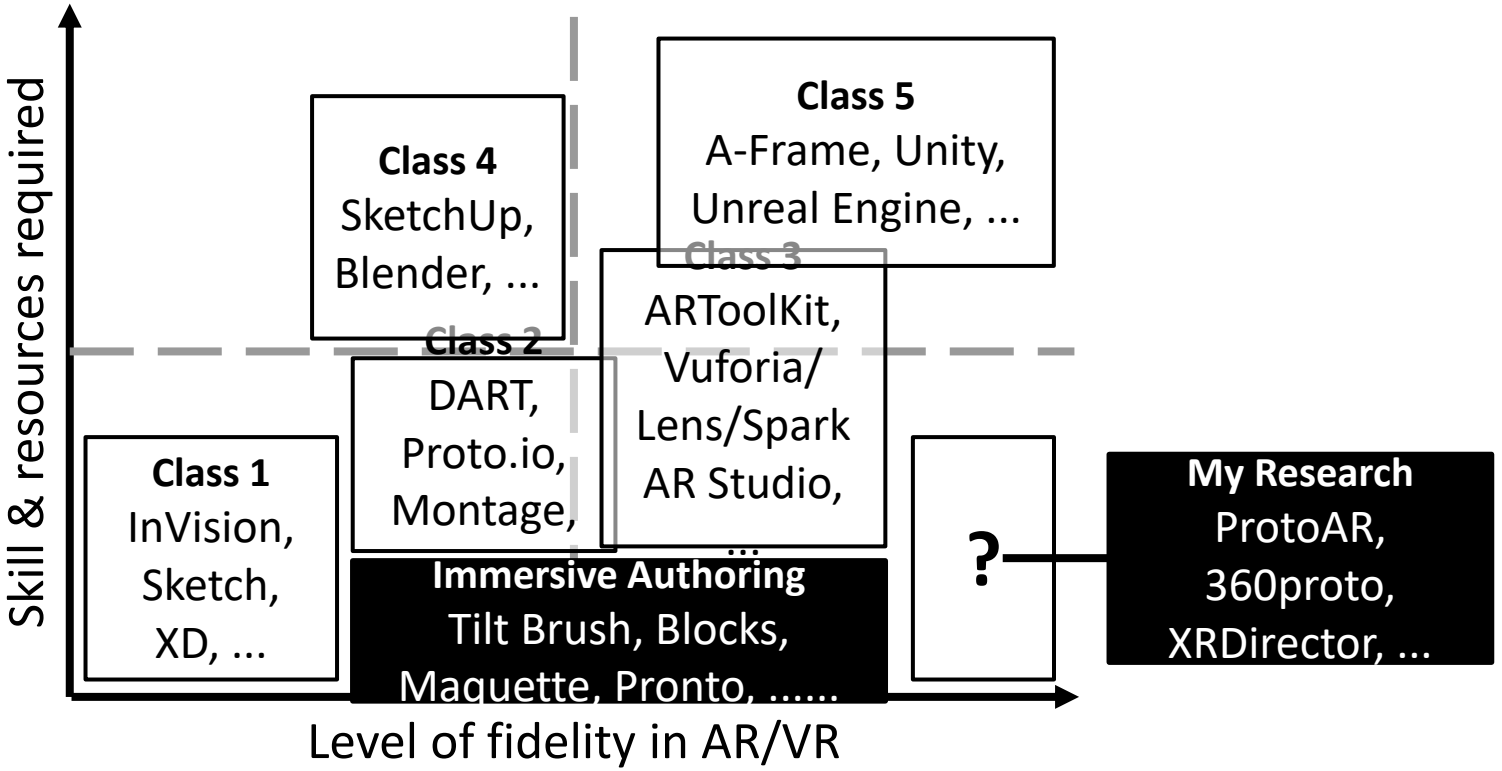
- Offer alternative ways to travel
- Use interface metaphors
- Use physical affordances
- Minimize explicit interactions
- Put important elements in the foreground, avoid periphery
- Provide visual *and* audio cues to guide users through tasks

Don'ts

- Move user without their input
- Reinvent reality
- Just copy/paste real world
- Rely on gestures *or* speech
- Have users read a lot of text
- Put lots of content in the HUD
- Remap controller buttons, break conventions

Research Directions

The Trouble with XR Prototyping Tools



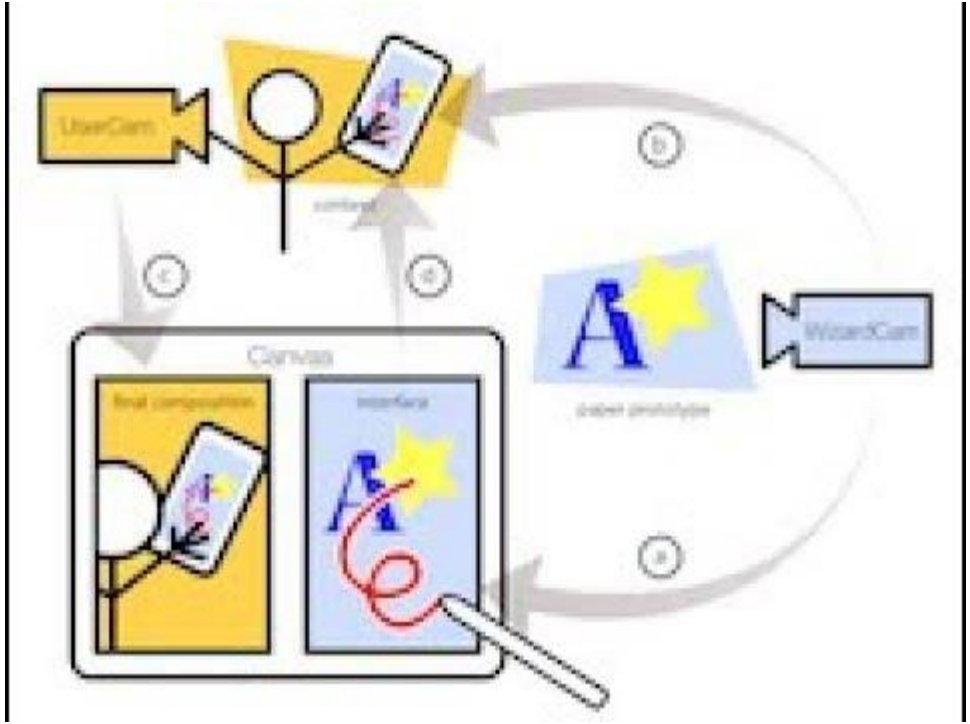
Research Directions

- Rapid physical-digital transition
- Interactive prototyping using Wizard of Oz
- On-device / cross-device / immersive authoring
- Visual scripting & asset/code generation
- Collaborative authoring

Rapid Physical-Digital Transition

ProtoAR by Nebeling et al. (CHI 2018)

Interactive Prototyping using Wizard of Oz

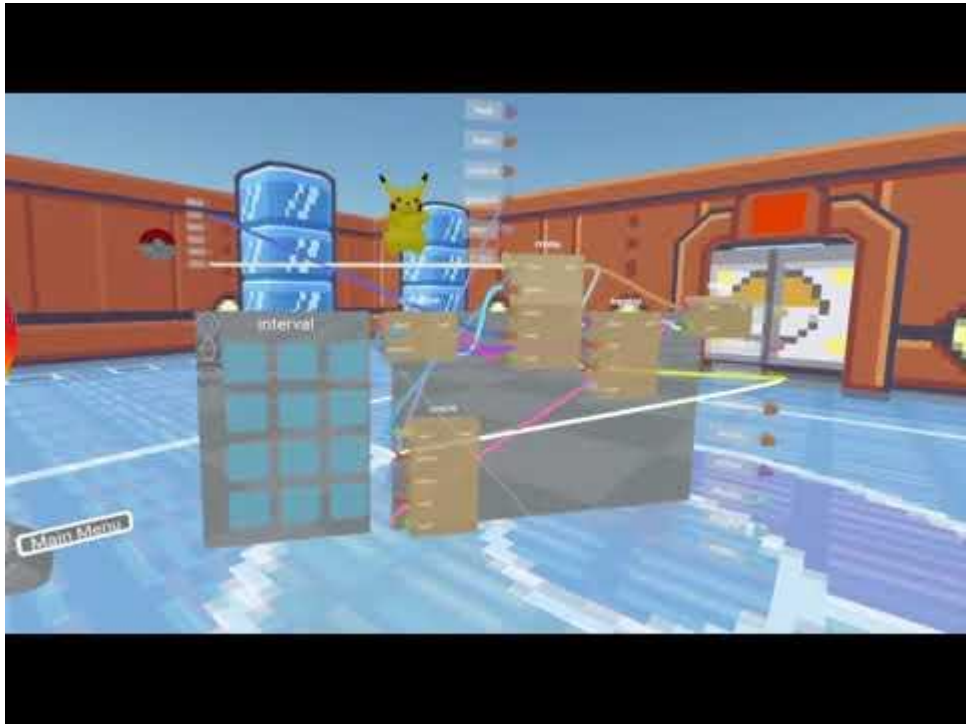


Montage by Leiva & Beaudouin-Lafon (UIST 2018)

On-device/Cross-device/Immersive Authoring

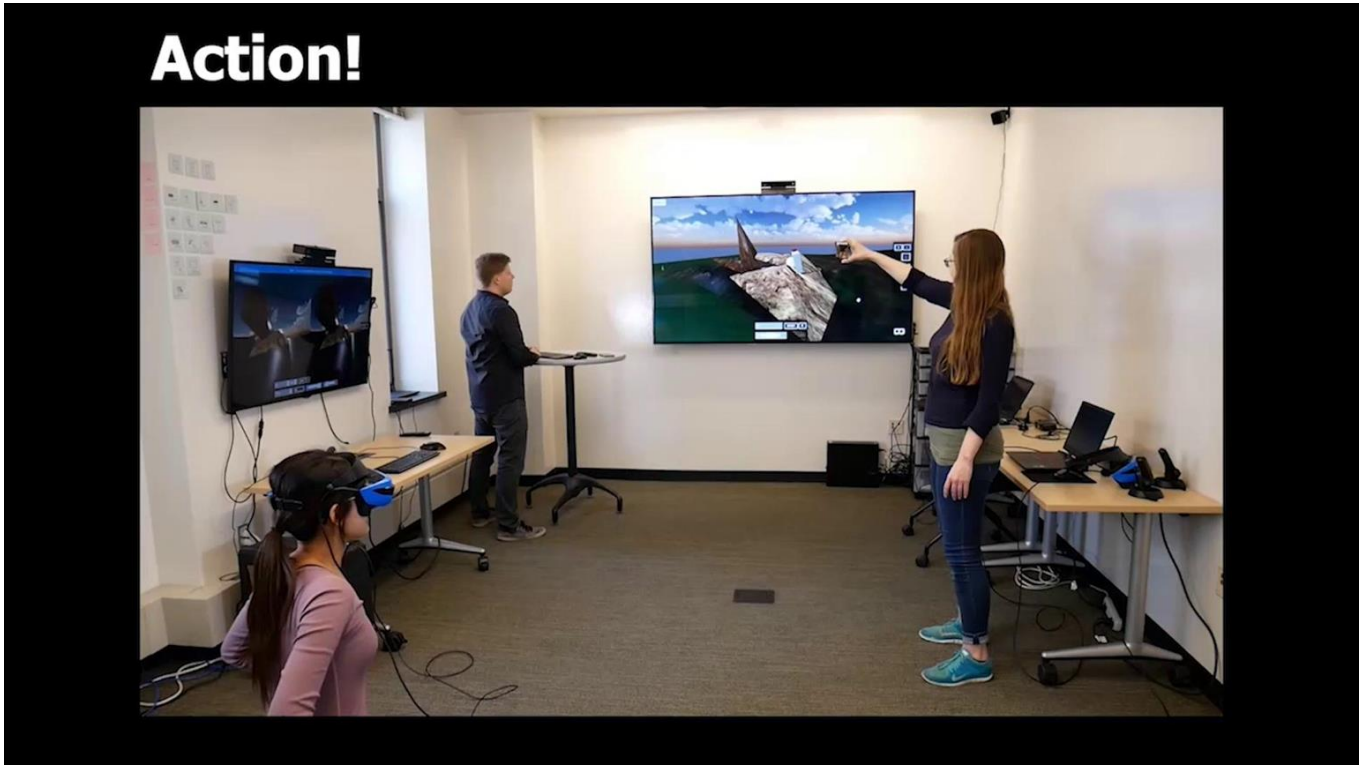
Pronto by Leiva et al. (CHI 2020)

Visual Scripting and Asset/Code Generation



FlowMatic by Zhang & Oney (UIST 2020)

Collaborative Authoring



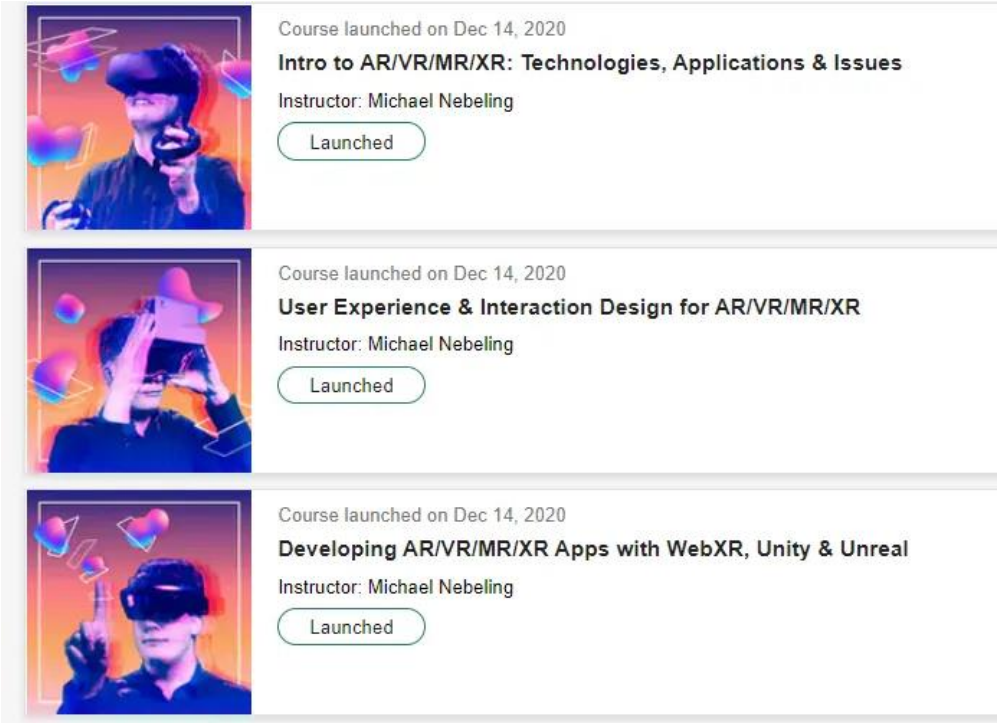
XRDirector by Nebeling et al. (CHI 2020)

Resources

XR Prototyping Web Site

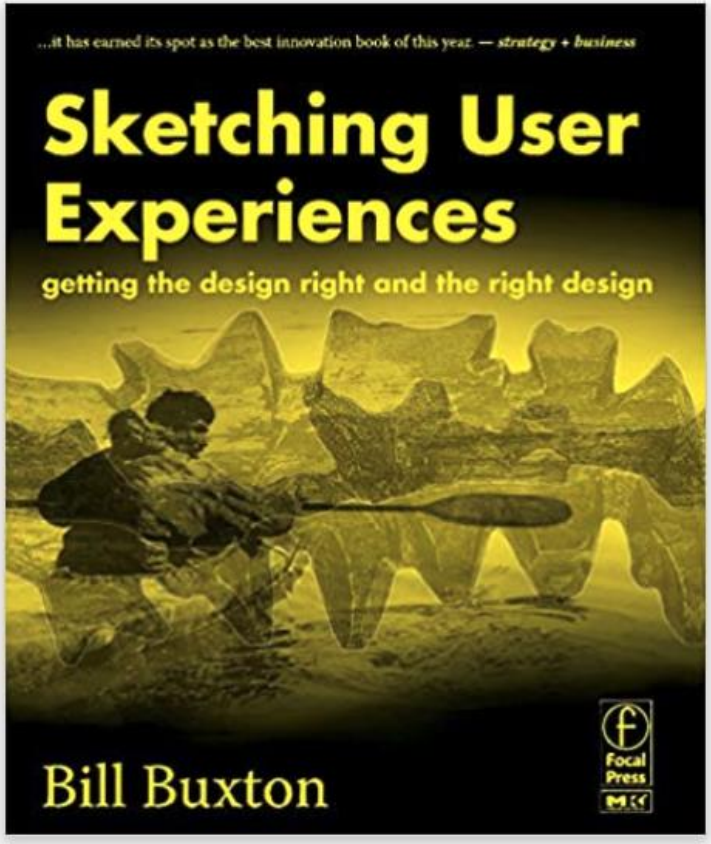
XR Prototyping resources (http://xr-prototyping.org/)

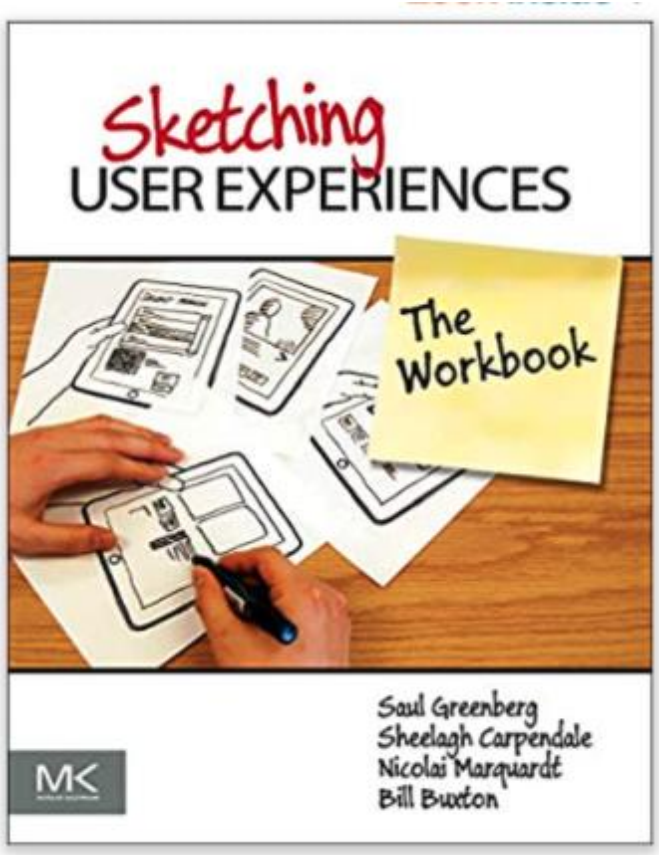
XR MOOC



XR MOOC on Coursera (http://xrmooc.com) -- free audit possible

Sketching Resources

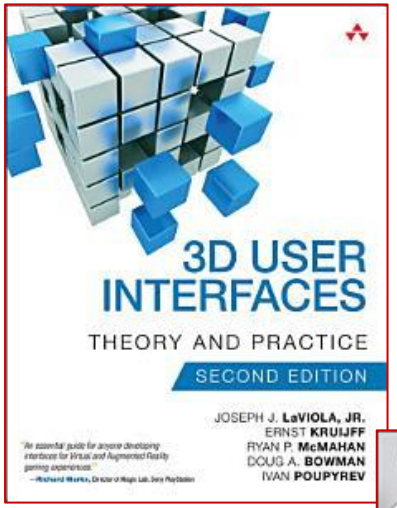




Other Books

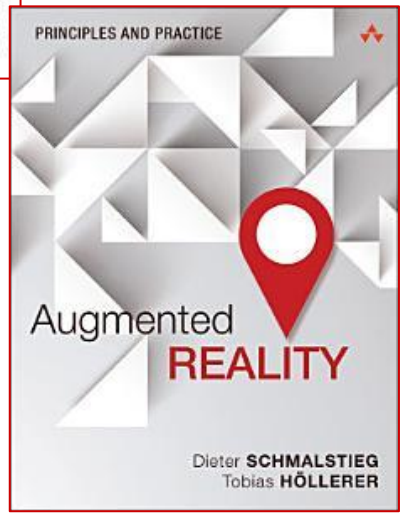
3D User Interfaces: Theory and Practice

Joseph J. LaViola Jr.Ernst Kruijff, Ryan P. McMahan, Doug Bowman, Ivan P. Poupyrev

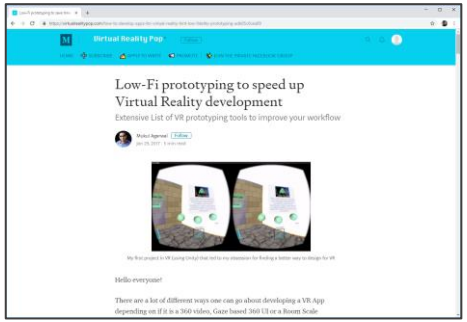


Augmented Reality: Principles and Practice

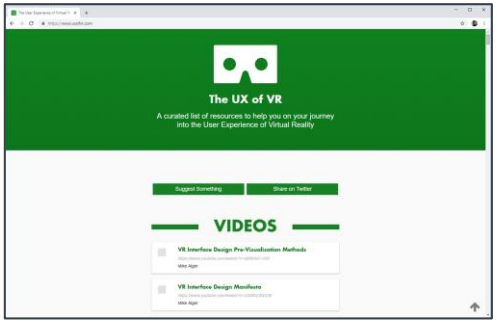
Dieter Schmalstieg, Tobias Hollerer



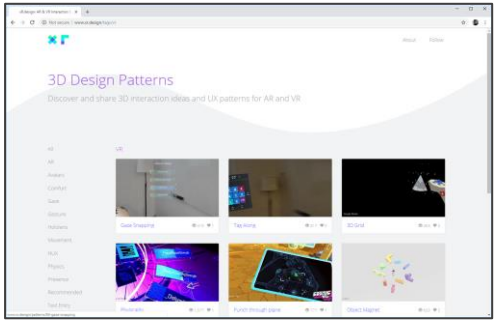
Tools and Guidelines



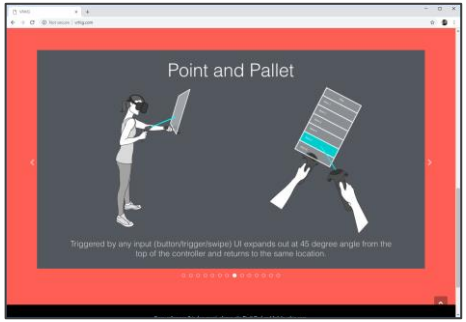
[Low-fi prototyping tools for VR]



[The UX of VR]



[3D design patterns for VR]



[Virtual Reality Human Interface Guidelines]

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